POWER

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HELPFUL HINTS

THESE comparisons could be continued indefinitely by showing the very rigid and intimate relationship between theory and practice in steam engines, steam turbines, gas engines, gears, refrigerating machinery, electrical machinery and many other appliances with which all engineers are familiar. Theory and practice are never at variance. They *must* agree. If they seem to disagree, one is wrong or both are wrong.

Theory and Practice

Theoretically, 2 x 2 = 4.	**Practically**, 2 x 2 = 4.
Theoretically, boiler-plate metal of a tested strength of 50,000 lb. per sq.in. will be safe for use in boilers if not stressed more than 8000 lb. per sq.in., provided it is not overheated.	**Practically**, boiler-plate metal of a tested strength of 50,000 lb. per sq.in. is safe for use in boilers if not overheated and if not stressed more than 8000 lb. per sq.in.
Theoretically, oil being a poor conductor of heat, will reduce boiler efficiency and will be a constant source of danger if permitted to coat the interior of the boiler. Theoretically, every trace of oil should be eliminated from the boiler-feed water.	**Practically**, oil is a poor conductor of heat. Oil **does** reduce boiler efficiency and **is** a constant source of danger when permitted inside a boiler. All good practical engineers are constantly doing all in their power to keep oil out of the boiler-feed water.
Theoretically, scale having been found also to be a very poor conductor of heat, will prove itself to be a source of fuel loss and danger if permitted to impede the progress of heat through a boiler shell.	**Practically**, scale, like oil, **is** a poor conductor of heat and daily proves itself to be a source of immense fuel loss and danger. Best boiler practice demands periodic scale removal or external purification.
Theoretically, cold feed water entering a boiler extracts more heat from the coal than necessary. This is especially true where the temperature of the feed water is considerably less than 210 deg. F. and where high-temperature flue gases and exhaust steam are being wasted.	**Practically**, cold feed water entering a boiler **does** extract more heat from the coal than necessary. Where economizers or feed-water heaters are installed a considerable saving of coal is effected. This is more pronounced in some plants than in others, depending upon the initial temperature of the feed water.
Theoretically, the first cost, cost of upkeep, cost of labor and depreciation are sometimes so high that installation of auxiliary economizing apparatus will prove ultimately unprofitable.	**Practically**, the first cost, cost of upkeep, cost of labor and depreciation are sometimes so high that installation of auxiliary economizing apparatus **does** prove ultimately unprofitable.

For example, when you find that your engine is not up to its usual capacity do not say: "**Theoretically**, now, this engine should pull a greater load than it is pulling. Boiler pressure, valve settings and everything are just the same now as they were yesterday when the engine pulled a big overload easily." The behavior of the engine in such an event is symbolic of practice and should teach that your theory is incomplete.

It would be more logical to say: "**Theoretically**, now, this engine should do exactly as it is doing. Although boiler pressure, valve settings and everything else *seem* to be just the same now as they were yesterday, something has gone wrong. I must apply an indicator and learn where the trouble is."

The cause of nearly every industrial accident can usually be traced back either to unsound theory or to poor practice. Boiler explosions, engine racing, flywheel explosions, backfiring, the bursting of cylinder heads and bridge failures are common accidents that might be named.

Do not scorn theory. Master the theory of every detail about your plant. When the theory of the best combination is clearly understood, practice that theory and you'll find that theory and practice run along hand in hand just as they should and just as they always do.

Contributed by W. F. SCHAPHORST, *New York City*

Large Savings in Remodeled Plant of Rockwell Manufacturing Co.

By installing a new power plant and changing from mechanical to individual motor drive in the factory, an annual saving in operating expense of $7440.23 was effected. Purchasing current under the most favorable contract obtainable and retaining the steam service would have increased the operating expense by practically the same amount. Features of the power plant are cleanliness, good lighting and ventilation, superheaters in a 250-hp. return-tubular boiler plant, highly efficient generating unit and an excellent system of records.

THE Rockwell Manufacturing Co., of Milwaukee, Wis., one of the oldest manufacturers in the Northwest of all millwork entering into the construction of a building, has recently remodeled its factory and installed a new power plant. Keenness of competition had made it necessary to widen the margin between producing costs and selling prices. Months were spent in studying operating costs, observing load conditions and tabulating the data. An analysis of these data by the Thos. S. Watson Co., consulting engineers, resulted in the installation of an unusually efficient power plant for a small institution, a change from shafts and belting to individual motor drive, an up-to-date lighting system, modern heating equipment, a new dust-collecting system and model lavatories. All this, in addition to work along welfare lines, increased and improved production and lowered the cost. The saving in the power plant was large. Briefly, it may be stated that the former producing capacity was preserved with one-third the number of boilers, an operating crew half as large as formerly, an engine and generator combined weighing 5000 lb. less than the flywheel of the old engine, a saving of 163 hp. in friction load and a reduction of $7500 annually in fuel expense. Credit is given to the installation of an efficient prime mover equipped with poppet valves for superheated steam, a high load factor, more efficient boilers, a reduction in friction by the elimination of the lineshafting and belting in favor of ball-bearing motors and more efficient use of the exhaust steam in the kilns and for heating.

The old plant contained a simple Corliss, 30½ x 60-in., with double eccentrics, installed in 1894. It was served by a jet condenser and operated at a speed of 64 r.p.m. The engine was bulky and weighed about 190,000 lb., half of this weight being in a flywheel 24 ft. diameter, with a 66-in. face. The rim speed was over 4800 ft. per min., and this enormous wheel had a shaft of 15 in. diameter. Power was transmitted to the factories by hundreds of feet of lineshafting and innumerable belts, the main driving belt on the flywheel alone costing $400. There were six horizontal-tubular boilers, four of 75 hp. and two of 95 hp. each, aggregating a total boiler horsepower of 490. These boilers

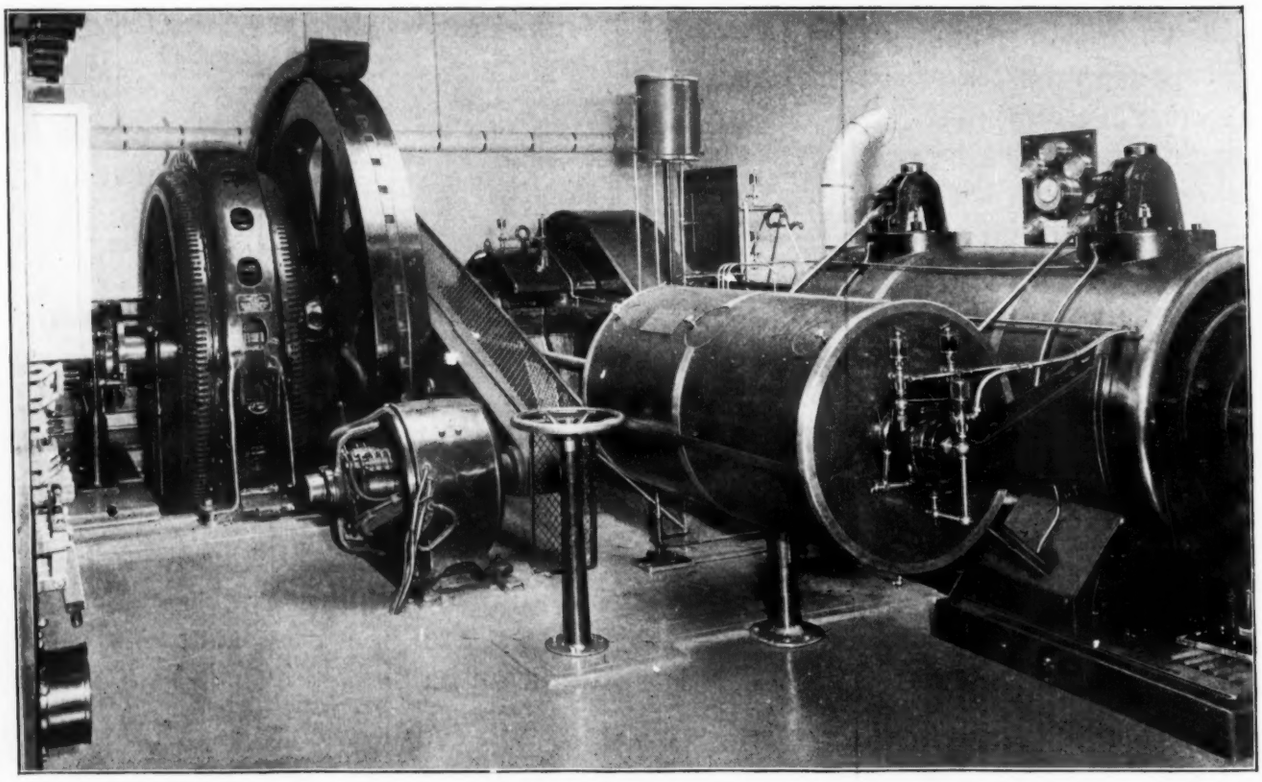


FIG. 1. EFFICIENT GENERATING UNIT IN ROCKWELL PLANT

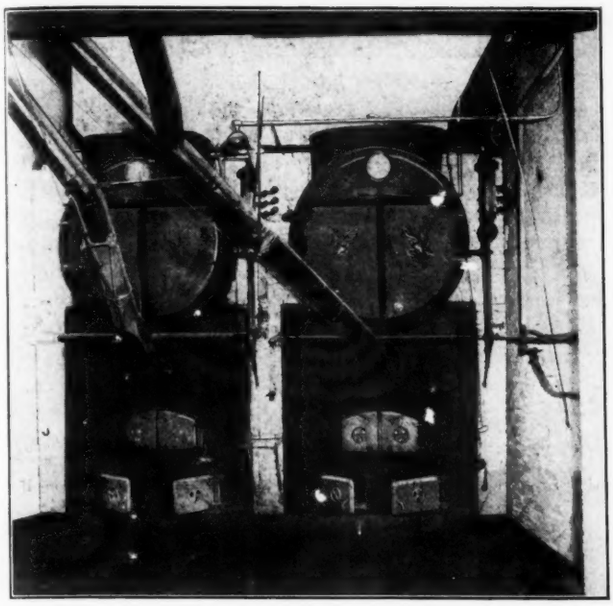


FIG. 2. BOILER PLANT EQUIPPED TO BURN WOOD WASTE

occupied the space now taken by the entire plant. Other miscellaneous equipment consisted of a 7½ & 4½ x 10-in. duplex and two 10 & 5 x 13-in. simplex boiler-feed pumps and an open feed-water heater of the vertical cylindrical type measuring 4 x 10 feet.

In determining the character of the new plant three plans were considered: First, the installation of a new steam plant; second, the equipment of the factory with motors and the purchase of current for power and lighting; third, the installation of equipment for producing and operating by electricity. The advantages and economies of motor drive quickly eliminated the continuation of belt drive. Although a comparison of estimated initial costs of mechanical and motor drives favored the former by 34 per cent., an annual saving in operation of 20 per cent. would be effected by the motor drive and if increased production, reduced labor expense, better lighting facilities, less belt slippage, loss of time from breakdowns and reduced personal hazard were to be considered, the additional saving might readily aggregate another 20 per cent.

Purchase of electricity for power and lighting was found inadvisable on account of excessive cost. In any event a boiler plant would be necessary for kiln-drying lumber and for heating. Besides, shavings and sawdust provided inexpensive and excellent fuel. The actual costs for the year 1916 confirmed this conclusion.

In the factory no attempt was made to split up the shafting into suitable sections, as is frequently done when revamping an old plant. A separate motor was provided for each machine, and in some instances a single machine is served by four motors.

As much of the service called for constant speed and a simple motor requiring little attention was desired, alternating current was the choice of the engineers. The generation was three-phase 60-cycle 220 volts, with three-wire distribution. Both lights and motors could thus be served without transformers. Ball-bearing induction motors of a heavier type than generally used were selected, as it was thought they would require less oil and less attention than motors of the sleeve-bearing type and would permit shorter belt centers. A total of 135 motors ranging in capacity from 1 to 50 hp. were installed.

In selecting the prime mover careful estimates were made of the steam required for the dry kilns, process purposes and for heating. Outside of the heating season it was found that the steam for power would exceed the dry kiln and process demand. The natural selection was a simple noncondensing unit with a steam rate as low as possible, so that the excess of exhaust steam during the nonheating season could be held to a minimum. The prime mover chosen was a poppet-valve engine to run at 150 r.p.m. on 150-lb. steam, superheated 100 deg. F. and against a back pressure of 3.5 lb. Under these conditions a steam consumption of 18 lb. per i.hp.-hr. was guaranteed, and in service the foregoing rate has been found to be conservative.

To arrive at the engine capacity the power required to operate the machines and motors was placed at 618 hp., to which was added 100 hp. for the dust-collecting system. In the total of 718 hp. no allowance was made for three elevators, the repair shop or the saw-filing room, as the operation was intermittent and would not overload the power plant. Statistics showed that best-managed wood-working plants averaged one-third of full load, so the requirements for factory power were 240 horsepower. Adding an estimate of 80 hp. for light gave 320 hp., for which load a 375-hp. engine was chosen. The generator, rated at 312 kv.-a., is direct-connected, with the exciter belted to the flywheel. A voltage regu-

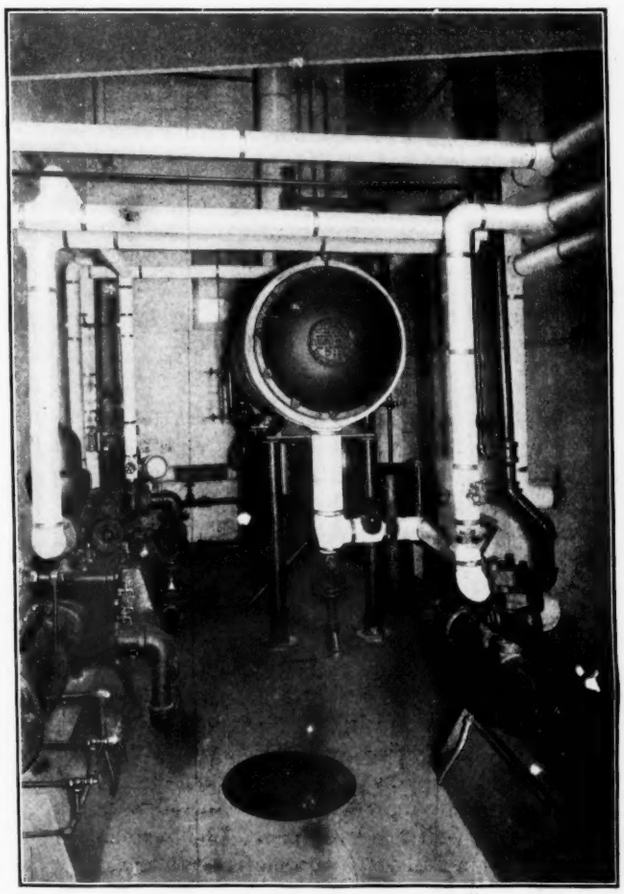


FIG. 3. PUMPS AND FEED-WATER HEATER

lator controls the voltage. A comparison of the power requirements of the two systems is given in Table I.

As, formerly, the main engine had been operated condensing, the only exhaust steam available was from auxiliaries such as the pumps and three small engines driving the lighting dynamo, dry-kiln fan and the elevator. This was used for heating a portion of the factories through 3445 lin.ft. of 1-in. piping, for heating the warming and glue boxes and a portion of the coils

TABLE I. POWER REQUIREMENTS OF THE TWO SYSTEMS

	Former	Present
Lineshafting, hp	163	0
Blower system (formerly 13, now 2 fans), hp	196	80
Constant load of shafting and fans, hp	359	80
Machines running idle, hp	134	0
For actual cutting operation, hp	69	69
Variable load (countershafts, machines and cutting operations), hp	203	0
Average load during ordinary operation, hp	562	286
Steam per i.hp. = hr. (condensing — 95 lb. boiler press.), lb.	22	..
Steam per i.hp. = hr. (non-condensing — 150 lb. boiler press.), lb	..	18

in the fanhouse. All the exhaust steam and the returns from the heating coils passed into the feed-water heater. The balance of the heating, amounting to 5488 lin.ft. of 1-in. piping, was effected by live steam. Under the new system exhaust steam is used for all drying and heating, and this is one of the fundamental factors tending toward higher economy.

With the installation complete, it developed that the steam was superheated 120 deg. and entered the engine cylinder at a temperature of 486 deg. Cylinder lubrication therefore was important and required a high-grade oil. It is fed into the cylinder by a power pump driven by an eccentric on the engine layshaft. Another grade of oil is used for the engine tail rod and piston rod and a third quality of lubricant for the bearings.

Relative to economy in the use of cylinder oil, it may be stated that over 11 acres of cylinder surface is lu-

TABLE II. COST OF CYLINDER LUBRICATION

Steam pressure, lb. gage		150
Superheat, deg. F		120
Steam temperature, deg. F		486
Cylinder oil used, gal		27.5
Cylinder oil cost, total		$15.13
Cylinder oil cost, per gal		$0.55
Cylinder size, in		20x32
Revolutions per minute		150
Engine operated, hour		2,898
Cylinder Surface Swept Piston Rings per	Revolution	27.92 sq.ft.
	Hour	251,280 sq.ft.
	Year (2,898 hour run)	728,209,440 sq.ft.
	Year (2,898 hour run)	16,717.39 acres
	Gallon	26,480,343 sq.ft.
	Cent	481,461 sq.ft.
	Cent	11.052 acres

bricated for one cent per year. Table II gives the figures for the year 1916, the first year of operation for the new plant. That the engine could be turned over by hand at any time was evidence of sufficient lubrication.

Two horizontal-tubular boilers 66 in. x 18 ft., replaced the former battery of six boilers. Each has approximately 1250 sq.ft. of heating surface and on a basis of 10 sq.ft. is rated at 125 hp. The capacity required was computed from the steam consumption of the engine. Multiplying the engine rating of 375 hp. by 18, the pounds of steam per indicated horsepower-hour, gave 6750 lb. of steam per hour. Under moderate driving a boiler will easily evaporate 3 lb. of water per square foot of heating surface. Thus dividing the steam requirement by three gave 2250 sq.ft., or on the basis of 10 sq.ft., 225 boiler horsepower. The installation of the two 125-hp. boilers gave some reserve capacity.

In the furnace the grates are divided into two lengths with a view to saving on renewal expense. To secure good combustion and to guard against smoke, the bottoms of the shells have been placed 48 in. above the grates.

Each boiler is equipped with a soot cleaner and a superheater within the setting at the rear. For boilers of this size superheaters are unusual, but an estimated steam saving of 18 per cent. would indicate that the installation was worth while. Other auxiliaries are a 400-hp. heater, a simplex double-acting feed pump, 6 & 4 x 10-in., a 6 & 8 x 10-in. simplex vacuum pump on the heating system and for reserve a simple pump, 8 & 5 x 13-in., so cross-connected that it may be used on the vacuum heating system or as a boiler-feed pump. In the way of instruments there are indicating and recording gages for steam-pressure, vacuum and back-pressure gages on the heating system and a thermometer on the feed-water line to register the temperature of the water entering the boilers.

After considering the possibilities of baling and selling the sawdust and shavings from the factory, it was decided more economical to burn them under the boilers. A blower system collects the waste from the various wood-working machines and discharges it into two large receivers on the boiler-room roof, from which this waste fuel flows by gravity into the furnaces. Hand-operated dampers direct the fuel under either one or both of the boilers. One 80-in. and one 90-in. double

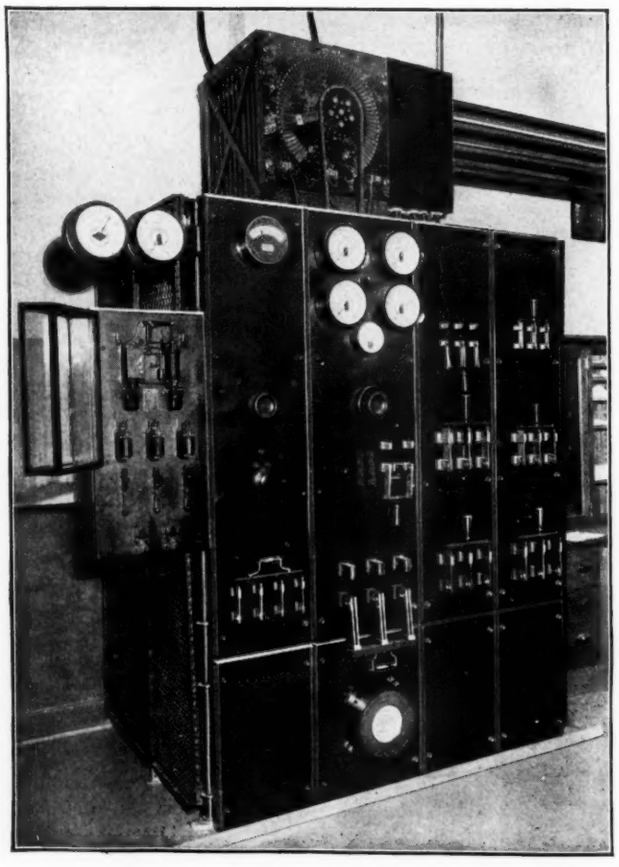


FIG. 4. FOUR-PANEL SWITCHBOARD

fans driven by 40- and 50-hp. motors, respectively, handle the waste material. They replace thirteen fans in the old system and in operation require 80 hp. as compared to 196 hp., a saving of 116 horsepower. As the

dry kilns are run continuously 8760 hours per year and the factory only one-third of this time, it is necessary to burn coal during nights and Sundays. For the year 1916 the coal bill amounted to $1435 as compared to $9269.94 for the previous year. A saving of $7834.94 in the coal bill was effected in spite of the fact that the fuel cost 60c. per ton more during the last nine months of 1916.

TABLE III. OPERATING DATA, SALARIES PAID AND SUPPLIES USED

Month	No. Hours in Month	No. Hours Power Produced	No. Hours Heated by Exhaust Steam	No. Hours Heated by Live Steam	No. Hours Live Steam Kept on Dry Kilns	Amount Power Produced Kw.-Hr.	Average Load, Kw.	Maximum Load for 15 Min., Kw.	Average Load Factor, Per Cent.	Tons Coal Used	Value Coal Used	Salary Chief Engineer	Salary Day Fireman	Salary Night Fireman	Gal. Engine Oil Use	Gal. Cylinder Oil Used	Lb. Grease Used	Lb. Grease Used	Lb. Rags Used	Lb. Waste Used	Lb. Boiler Compound Used
Jan.	744	209	209	535	.....	38,360	183.5	215	85.36	70.34	$122.44	$125	$76.59	$56.60	34	12	.....	.....	7	.....	14
Feb.	696	216	216	480	348	40,650	188.2	225	83.55	63.52	174.69	125	65.00	64.80	30	5	.....	.....	8.5	.....	13
Mar.	744	245	245	499	.....	47,770	154.2	250	78.00	51.57	141.82	125	67.11	65.85	32	5	.....	.....	3	6	17
Apr.	720	234.5	234.5	485.5	360	43,490	185.4	225	82.43	54.14	172.21	125	65.00	63.16	27	7	5	2	7	7	20
May	744	258	258	.....	486	45,390	176	225	78.22	46.74	151.90	125	70.00	77.40	19	8	5	3	11	7	20
June	720	242	.....	.....	454	42,490	176	200	88.00	40.9	133.00	125	66.56	60.65	25	8	2.5	.....	9	.....	29
July	744	224.5	.....	.....	289.5	37,680	168	200	80.00	19.43	63.13	125	68.70	70.58	9	6	2	.....	7	.....	24
Aug.	744	252	.....	.....	373	45,890	182	200	91.00	10.265	33.36	125	74.00	66.75	8	7	2.5	3	9	3	24
Sept.	720	238	238	.....	420	45,975	193	200	96.50	6.775	22.02	125	75.00	73.50	10	8	2.5	.....	5	.....	18
Oct.	744	276	276	.....	308	54,935	199	200	99.50	7.65	24.86	125	75.00	70.00	12	8	3	.....	10	.....	63
Nov.	720	248	248	472	472	49,055	198	200	99.00	39.138	127.20	125	75.00	70.00	10	13	2.5	.....	5	5	87
Dec.	744	255	255	489	489	54,495	213.7	240	89.00	60.73	197.37	125	80.40	75.40	12	8	2.5	.....	16	.....	75
Totals...	8,784	2,898	2,179.5	2,960.5	3,999.5	546,180	.....	...	.....	471.198	$1,435.00	$1,500	$858.36	$814.69	228	95	27.5	8	97.5	28	434
Av. per month..		241.5	181.7	247	333	45,515	185	215	87.50	39.27	$119.59	$125	$71.53	$67.89	19	7.9	2.3	0.66	8.1	2.3	33.7

The advantages of keeping adequate records even in a small plant have been demonstrated in the present case. The chief engineer maintains a daily record of operation, the daily logs are condensed into monthly charts and the latter into an annual report with analyses of the various factors entering into the cost of operation. As a further inducement toward economy the plant is kept remarkably clean. The firm believes that environment has an influence and that cleanliness pays big dividends. The boiler room has a concrete floor, the walls are painted white and even the coal bin is whitewashed. It is possible to keep it clean as comparatively little coal is burned. The engine room and all machinery are neatly painted, and ample light and ventilation are provided. Every inducement for high standards is thus offered, and the records of the plant show that favorable operating conditions had the desired effect.

TABLE IV. SUMMARY OF POWER, LIGHTING AND HEATING COSTS

Operating labor	$3,173.05
Coal purchased	1,435.00
Miscellaneous supplies	205.18
Operating cost	$4,813.23
Fixed charges (15% on $29,128.59)	4,369.29
Total cost	$9,182.52

TABLE V. STEAM GENERATION AND COST PER 1,000 LB.

Live steam generated:	
Prime mover, lb.	16,385,400
Live steam for dry-kilns, lb	10,000,000
Live steam for heating, lb	1,800,000
Total	28,185,400
Cost of generation:	
Fixed charges (⅛ of total)	$2,184.64
Boiler room labor	1,673.05
Supervision (⅛ of chief engineer's salary)	500.00
Coal purchased	1,435.00
Miscellaneous supplies (⅛ of total)	102.59
Total	$5,895.28
Steam cost per 1,000 lb	$0.209

Although the steam piping is comparatively short, it is interesting to look over the deductions made as to the possible saving to be effected by covering. All piping in the plant carrying steam at 150 lb. pressure and 120 deg. superheat is covered with two layers of asbestos millboard ⅛ in. thick, each layer being bound to the pipe with copper wire. The purpose of the second layer was to fill the space that otherwise would have existed within the outside molded covering. Over the two layers of millboard is placed 85 per cent. magnesia sectional pipe covering of standard thickness. Piping carrying steam at 80 lb. pressure and 120 deg. superheat is covered with a standard thickness of 85 per cent. magnesia sectional covering and the exhaust piping with one thickness of standard asbestos molded sectional covering.

TABLE VI. COST OF GENERATING CURRENT

Steam charge (exhaust steam, credit deducted	$1,032.54
Supervision (⅛ engineer's salary)	1,000.00
Miscellaneous supplies (⅛ of total)	102.59
Fixed charges (½ of total)	2,184.65
Total	$4,319.78
Kilowatt-hours generated	546,180
Cost per kilowatt-hour	0.79c.

As an illustration of the saving resultant from the covering, the following steam lines, aggregating 111.25 sq.ft. of radiating surface, were taken; 4-in. steam lines from boilers to superheaters, 37 sq.ft.; 5-in. steam line from superheaters to receiver, 40.75 sq.ft.; engine side pipes to entrance to receiver, 33.50 sq.ft. The following assumptions were made: Steam at an average pressure of 145 lb. gage and 120 deg. superheat, giving a temperature of 483.4 deg. F.; temperature of external air at location of pipes, 100 deg. F.; 3 B.t.u radiated per square foot of bare pipe for every degree difference in temperature between the steam and the air. In the present case this difference in tempera-

TABLE VII. COMPARATIVE COSTS OF OPERATING OLD AND NEW EQUIPMENT

	Old Equipment (1913)	New Equipment (1916)
Coal, 3,498 tons @ $2.65	$9,269.94	
Coal, 471.198 tons @ $2.75 and $3.25		$1,435.00
Wages	4,986.35	3,173.05
Water	498.46	122.34
Boiler repairs	757.67	
Boiler and entire plant repairs		902.12
Belt repairs	585.00	265.68
Oil and waste	310.24	113.64
Boiler compound	37.00	19.54
Packing	39.59	00.00
Boiler insurance	61.67	55.00
Miscellaneous	00.00	75.00
Operating costs	$16,545.92	$6,161.37
Fixed charges (15% on $9,500)	1,425.00	
Fixed charges (15% on $29,128.59)		4,369.32
Total costs	$17,970.92	$10,530.69

Difference in favor of new plant, $17,970.92 — $10,530.69 = $7,440.23.

ture amounts to 383.4 deg. Then the heat radiated per hour from the bare piping would be 383.4 × 3 × 111.25 = 127,960 B.t.u., or 8760 × 127,960 = 1,120,929,600 B.t.u., the total loss per year. With the steam containing 1193 B.t.u. per pound above 100 deg., the temperature of the air, the annual loss in steam would amount to 939,589 lb. In 1916 the steam cost 20.9c. per 1000 lb. so that in money the wastage would represent the equivalent of $196.37, provided the covering was perfect. As the latest data give 84 per cent. as the efficiency of magnesia covering, the insulation of the high-pressure steam piping saves annually $165, or with fuel at $3.25 per ton, over 50 tons of coal.

In tables III to VII are given the operating data and costs of the plant for the year 1916. Table III gives the operating data relating to hours of steam and electric service, coal, labor and supplies. Table IV summarizes the total cost for power, light and heat, the operating cost being $4813.23, the fixed charges $4369.29 and the total cost $9182.52.

In carefully computing the steam for the different services, it was found that the dry-kilns used 10,000,000 lb. of live steam per year and 7,245,000 lb. of exhaust steam. On a basis of 600 lb. of steam per season per square foot of radiation, the 10,000 sq.ft. of surface in the heating system required 6,000,000 lb. of steam. It was estimated that 30 per cent. of this amount was live steam and 70 per cent. exhaust steam, or 1,800,000 and 4,200,000 lb. respectively. In generating 546,180 kw.-hr. per year on a basis of 30 lb. per kw.-hr., including a small allowance for small engines and pumps, the prime mover used 16,385,400 lb. of steam. To fulfill the demands required an annual steam generation of 28,185,400 lb. at a cost of 20.9c. per 1000 lb., as shown in Table V.

Reference to the previous paragraph will show that the dry kilns used 7,245,000 lb. of exhaust steam and the heating system 4,200,000 lb., making a total of 11,445,000 lb. After deducting energy for power and feedwater heating, it was estimated that 80 per cent. of the steam supplied the engine would be available for heating, or 13,108,320 lb. From the figures given 87.3 per cent. of the available exhaust steam would be utilized. It is evident that only 16,385,400 — 11,445,000 = 4,940,400 lb. of steam should be chargeable to the generation of electrical energy. At 20.9c. per 1000 lb., this would amount to $1032.54. Adding this figure to the other engine-room charges, as in Table VI, gives a total generating cost of $4319.78, or 0.79c. per kilowatt-hour.

Purchased current under the most favorable contract would have cost $12,781.80. Deducting 5 per cent. for prompt payment leaves a balance of $12,142.71, a net charge of 2.22c. per kilowatt-hour a difference of 1.43c. per kilowatt-hour.

The boiler-room charges to supply 23,245,000 lb. of steam needed by the dry-kilns and heating system would duplicate those of Table V, with the exception of the fuel item. On the basis that there would be enough waste material for fuel so that there would be no coal charge, the steam service would cost annually $4460.28. The total cost of operating the plant would then be $12,142.71 + $4460.28 = $16,602.99, as compared to $9182.55 under the present arrangement. The annual difference in favor of the isolated plant is $7420.44.

NEW EQUIPMENT OF ROCKWELL PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Engine	Poppet-valve	375 hp	Driving direct-connected generator	150 r.p.m., 150 lb., 100 deg. superheat	Nordberg Mfg. Co.
1	Generator		312 kv.-a	Main generator	150 r.p.m., engine-driven	Allis-Chalmers Co.
2	Boilers	Return-tubular	66 in. x 18 ft., 1,250 sq.ft.	Main steam generators	150 lb. pressure, 100 deg. superheat	Freeman & Sons Mfg. Co.
2	Superheaters	Foster		With steam boilers	100 deg. superheat	Power Specialty Co.
1	Heater	Hoppes	400 hp	Boiler-feed water	Live steam, 150 lb	Hopper Mfg. Co.
1	Pump	Simplex	6 x 4 x 10 in	Boiler feed	150 lb. steam	Dean Bros. Steam Pump Works
1	Pump	Simplex	6 x 8 x 10 in	Vacuum on heating system	150 lb. steam	Dean Bros. Steam Pump Works
1	Pump	Simplex	8 x 5 x 13 in	Reserve, vacuum on boiler feed	150 lb. steam	Cameron Steam Pump Co.
1	Oiling system	Richardson-Phenix		Bearing lubrication and oil filter		Richardson-Phenix Co., Milwaukee, Wis.

Table VII gives an interesting comparison of the operating costs of the old and new equipment. The difference between the two totals is $7440.23 in favor of the new plant, a saving of 41.4 per cent. Excluding the fixed charges, the annual saving in operation is $10,384.55.

For the data and information contained in this article credit is due John H. Moss, president of the Rockwell Manufacturing Co., and Charles A. Cahill, mechanical engineer with the consulting engineers having the work in charge.

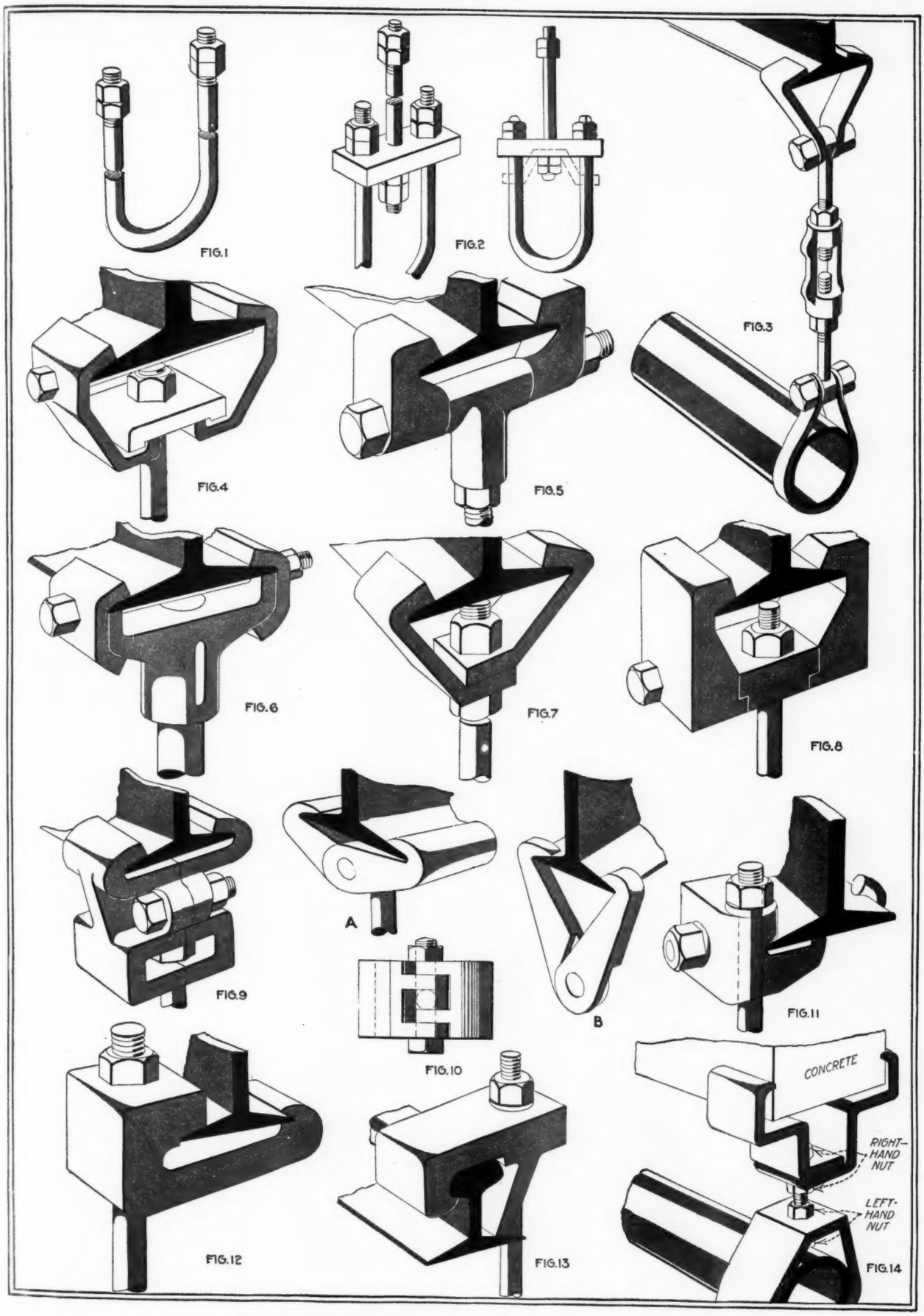
Various Types of Pipe Hangers

BY A. J. COHEN

The common U-bolt, as shown in Fig. 1, forms about the simplest and cheapest pipe hanger when there exists a suitable structure overhead for attaching it. The rod should be threaded for a considerable distance on each end for adjustment, and for pipes subject to vibration, such as steam, exhaust, hydraulic-pressure lines, etc., there should be jam nuts or other form of nut locks. Where the distance to the point of support is excessive, or the overhead structure favors attachment at a single joint, the pipe hanger in Fig. 2 is suitable. If a flat bar is used for the crossbeam, it should be bent as shown in dotted lines.

Fig. 3 illustrates a complete hanger with clamp suitable for attachment to the lower flange of an I-beam. The strap in which the pipe rests is made from a broad flat bar of wrought iron or steel, varying in thickness from $\frac{1}{8}$ in., or even less for very small pipes, to $\frac{3}{8}$ or $\frac{7}{16}$ in. for large pipes. A turnbuckle with locknuts provides a means for adjusting the length. The rod ends in the turnbuckle are upset to give the same strength at the root of the thread as in the full section of the rod, and the whole forms a strong, sightly hanger suitable for nearly any location where minimum cost is not considered a matter of first importance.—*American Machinist.*

Some day engineers will learn that the only language the owner understands is so many pounds of steam or kilowatt-hours per dollar and not per ton of coal?



VARIOUS TYPES OF PIPE HANGERS ILLUSTRATED

Tom Hunter, Hoisting Engineer

By WARREN O. ROGERS

At the stamp-mill power plant several types of engines were found. Four of them were originally used for hoisting purposes, but on three the link reversing gear had been removed and the engines were directly connected to alternating-current generators. The newest installation was a 10,000-kw. mixed-pressure turbine using exhaust steam from a number of stamps and auxiliary turbines.

AS WE entered the power plant of the Calumet & Hecla stamp mill, we were confronted by three Leavitt-type three-cylinder compound condensing engines, each directly connected to a 2000-kw. 12,300-volt a.-c. generator, and running at 107 r.p.m. We were informed that these units furnished current for about 250 motors ranging up to 700 hp. Each of these engines (Fig. 1) had one 24-in. high-pressure cylinder and two 40-in. low-pressure cylinders and a common stroke of 48 inches.

"I believe it was in 1886," volunteered Hunter, "that Mr. Leavitt began to design triple-expansion engines with the high and intermediate cylinders above one end of the beam and the low-pressure cylinder above the other end; of course the high and intermediate pistons worked in the same direction at the same time.

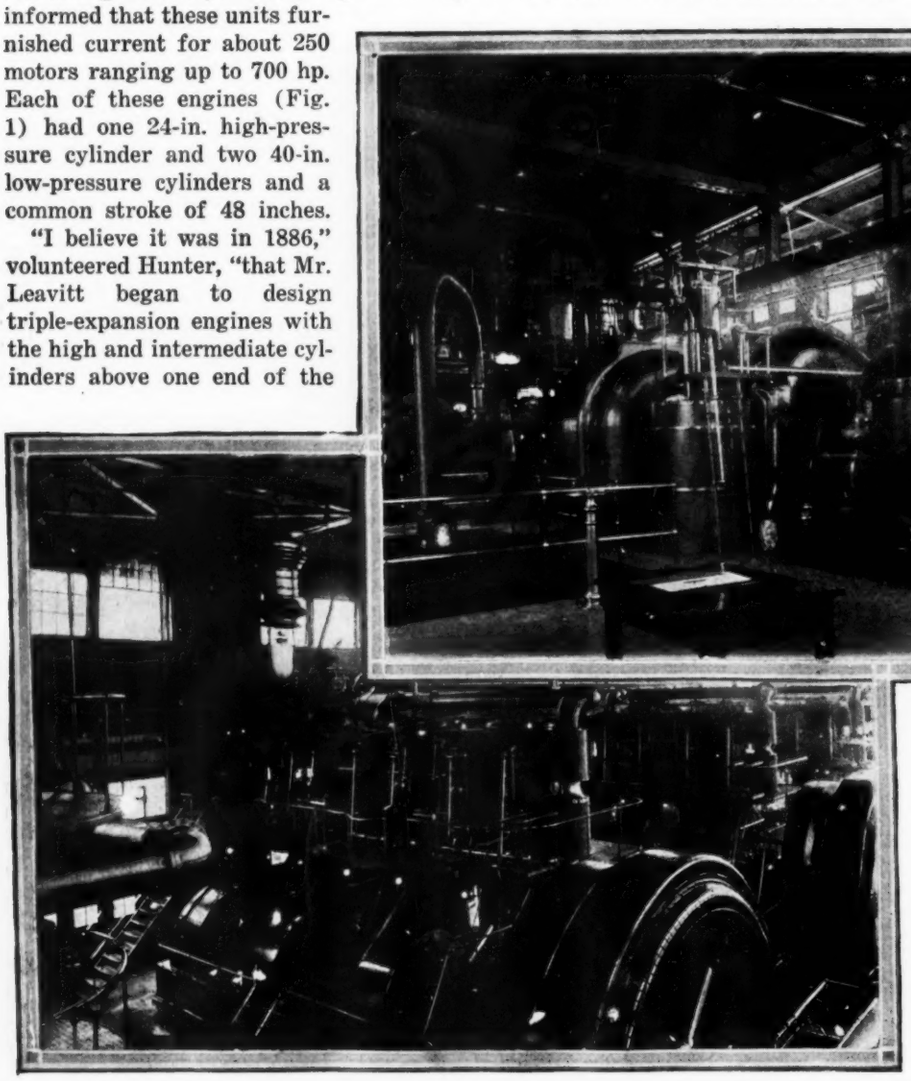


FIG. 1. LEAVITT THREE-CYLINDER COMPOUND ENGINES

"In some of his later triple-expansion and three-cylinder compound engines three beams were used, as we find with these engines, and each piston was connected to one end of each beam. These three connecting-rods connected with three cranks set 120 deg. apart. In these stamp-mill engines a departure is made in the design of the valve gear, and although gridiron valves are used, the gear is not operated by cams as in all of the other Leavitt type of engines we have seen, but it is operated by eccentric rods and the valve gear is provided with latches and dashpots, as on the Corliss engine gear."

"What was his idea in changing from his original design? Of course there was a reason."

"Sure there was. You see these engines were originally built for reversing hoisting units and the valves could be controlled better by using reversing links than by using reciprocating cams, such as we saw at the Red Jacket mine on the Minong and Siscowit engines."

FIG. 2. MIXED-PRESSURE TURBINE OF 10,000-KW. CAPACITY

"You see, these engines have no reversing links, with which they were originally equipped." See Fig. 3. "When it was decided to use them to drive electric generators, the reversing link was removed, and they have since been operating as you see them now. The automatic cutoff, which takes place on all three cylinders according to the load, is controlled by a rod from the governor."

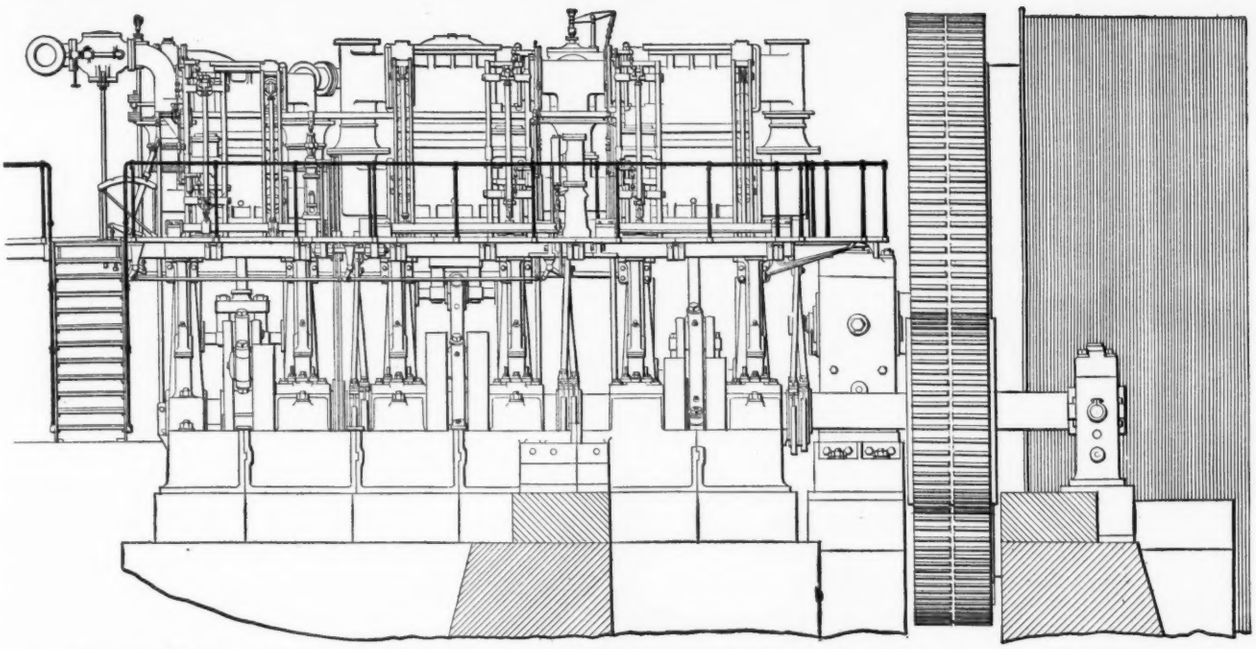


FIG. 3. ELEVATION OF THREE-CYLINDER COMPOUND ENGINE AS ORIGINALLY EQUIPPED WITH LINK REVERSING GEAR

While Hunter was talking, we made our way up to the switchboard balcony, from which point we obtained a good view of the entire plant.

"There is an engine of a design that is seldom seen in operation nowadays," said Hunter. "It is called the steeple compound by American operators on account of having two vertical cylinders, one above the other." See Fig. 4. "It is really a twin-compound engine, there being two high- and two low-pressure cylinders for driving two cranks on one shaft. The idea is about the same as what you have seen in tandem-compound hoisting engines at some of the mines, except that the cylinders are vertical instead of horizontal."

"What's the idea in sticking the cylinder up in the air? I don't see any advantage except that floor space is saved."

"That type of engine was originated in Europe, where several designs have been in use for years. On this side we tacked on the Corliss valve gear to make it conform to American practice. I suppose the idea originated from the fore-and-aft vertical-compound and other multiple-cylinder marine engines. As you say, it has the advantage of saving floor space, but they are difficult machines to work on while repairing and making adjustments. Quite a number of them have been built, but that type has seen its day. This particular engine has two 17-in. high- and two 40-in. low-pressure cylinders, with a common stroke of 48 in. and drives, directly connected, a 1000-kw. a.-c. generator running condensing at 94 revolutions per minute."

At this point Hunter stopped talking long enough for me to take several photographs, the last one being of an old-timer, I should judge from its appearance. This engine, Fig. 5, was next to the steeple-compound unit and drove a 1000-kw. generator by rope drive. The engine had originally been used for hoisting purposes and had been turned over to the power station. It was not running and had not been for some time; probably its best days are over, and it will doubtless round out the remainder of its service as a spare unit to be used for emergency only and finally discarded to make room for another turbine. It was a triple-expansion engine with 18 and 27¾ x 48-in. cylinders and a common stroke of 90 in. The valve gear was of the

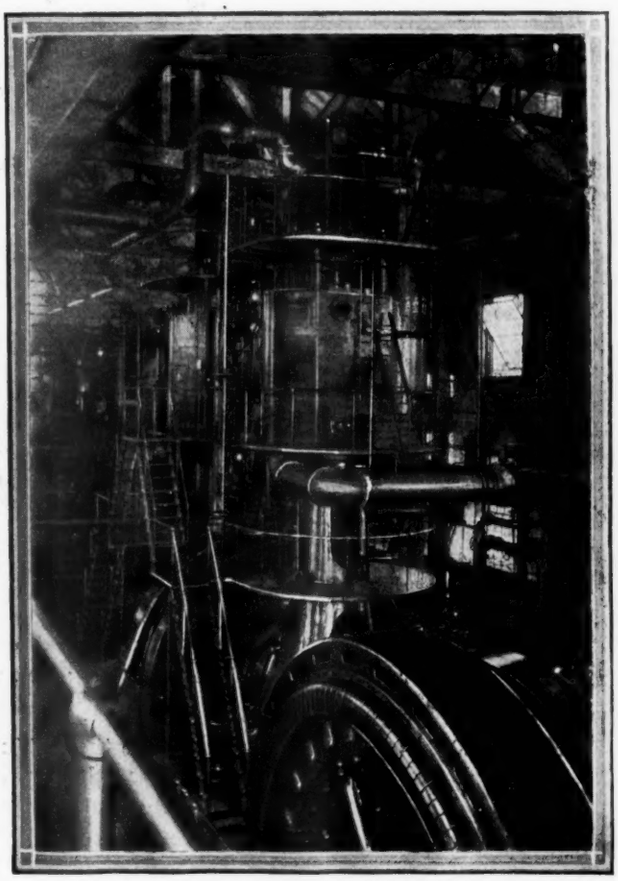


FIG. 4. STEEPLE-COMPOUND ENGINE DRIVING GENERATOR

ordinary Leavitt cam-operated design. A view of the grooved driving wheel is shown in Fig. 6.

"We have one more unit to see and that will settle this plant," remarked Hunter, as we descended to the engine-room floor again. "This is the latest machine they have put in," he continued, pointing to a 10,000-kw. turbine, Fig. 2. "It is what is called a mixed-pressure unit. That is, it uses the exhaust steam from about 17 stamp mills and from a number of turbine auxiliaries."

"Is that a paying proposition?" I asked, thinking of the back pressure that would be put on the stamp exhaust by the long line between the stamps and the turbine.

"It surely is. For instance, this turbine carries about 6000 kw. on the low-pressure side and 4000 kw. on the high-pressure side, which operates with steam at 160 lb. boiler pressure. The exhaust steam from the stamps comes to the low side of the turbine at 2½ lb. pressure. Assuming that the low side of the turbine will develop a kilowatt-hour on about 42 lb. of steam, that would mean in this case that the low side of the turbine, which I notice is working with a 28.6-in. vacuum, is using 252,000 lb. of steam that was, before the turbine was installed, condensed without doing any useful work."

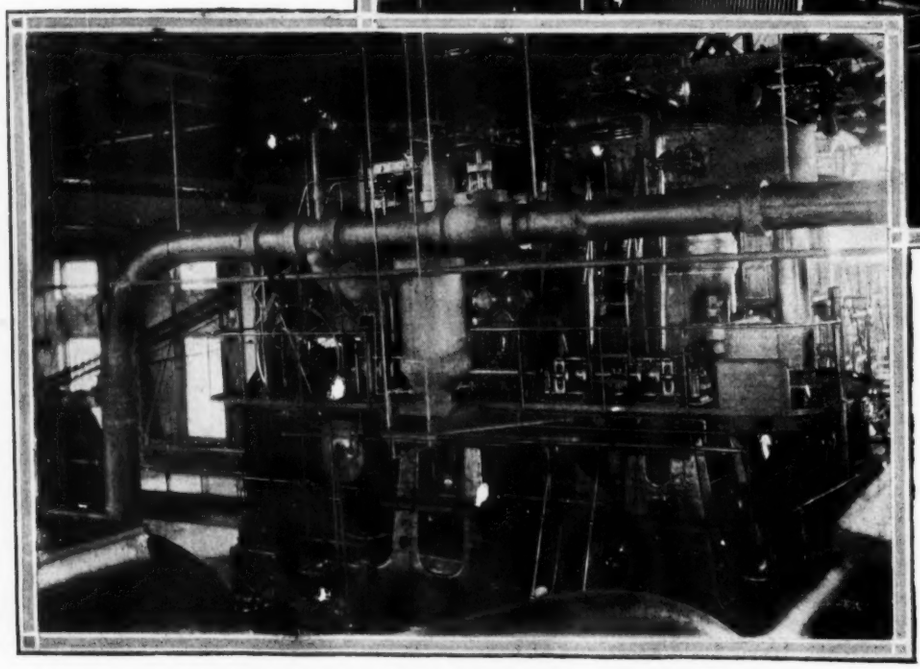


FIG. 5. OPERATING DECK OF AN OLD HOISTING ENGINE NOW USED TO DRIVE A GENERATOR

"Well, the steam from the stamp that was condensed was used in the boilers, wasn't it? All its heat was not lost."

"It is used now, for that matter," replied Hunter, "but after providing 6000 kw.hr. of electricity. Of course, this steam does not all come from the stamps, as considerable comes from the turbine auxiliaries. Now, not knowing the steam consumption of the stamps, we can't figure the saving in that direction, but taking an evaporation of 9 lb. of water per pound of coal, then 252,000 ÷ 9 = 28,000 lb., or 14 tons, of coal necessary to evaporate that amount of steam. Utilizing the exhaust steam has resulted in shutting down some of the engines and in a considerable gain in economy.

"Of course, a stamp is not the most economical steam-using machine. Mr. Leavitt designed his stamp because he found that there was plenty of room for improvement. It had two pistons on the same rod, the upper one being larger than the lower." See Fig. 7. "The steam from the bottom piston acts upon the top of the upper and largest piston, the steam being controlled by a gridiron valve, and the exhaust steam going to a condenser was controlled by another. Both valves were cam-operated.

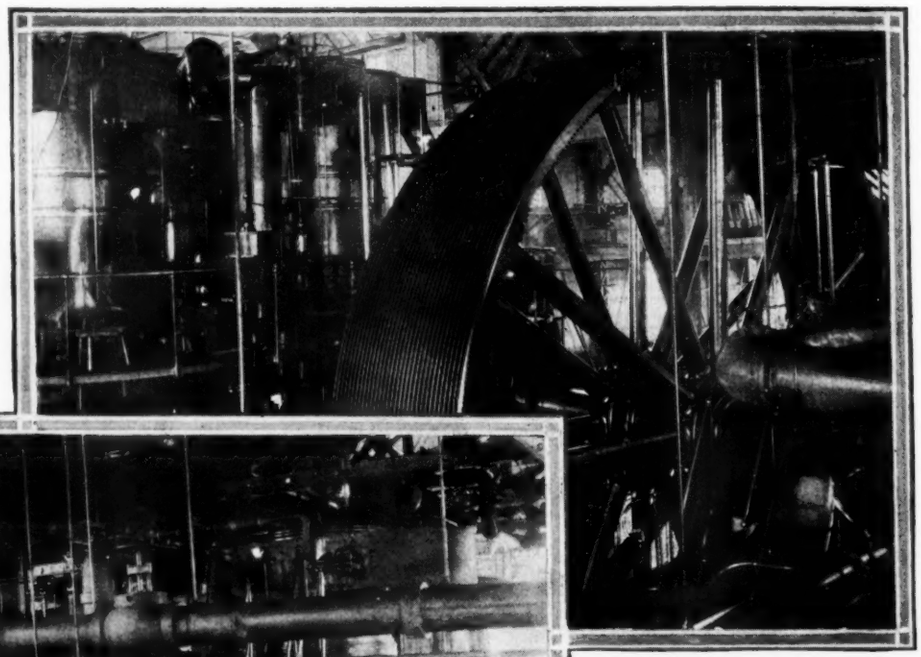


FIG. 6. GROOVED DRIVING WHEEL ON THE ENGINE SHOWN IN FIG. 5

"In this machine the space between the upper and the lower piston is always open to the condenser. You see, the space below the bottom piston is filled with live steam at boiler pressure and its work is to lift the stamp. The downward stroke of the piston is limited by the lower piston entering a compression chamber at the bottom of the cylinder and the up stroke is controlled by the lower piston entering a dashpot, which retards the piston without shock. These machines make about 110 blows per minute. It is the exhaust steam from these stamps that now goes to the mixed-pressure turbine instead of direct to a condenser."

"That is the second time you have called that machine a mixed-pressure turbine. What do you mean by the term?"

"I mean just what I say—that more than one initial pressure is used by the turbine. That is, it is designed to run with either high- or low-pressure steam or with both at the same time. As you can guess, there are two steam inlets, one for the high-pressure steam which passes through all stages of the turbine, and one for the low-pressure steam which passes only through the lower stages."

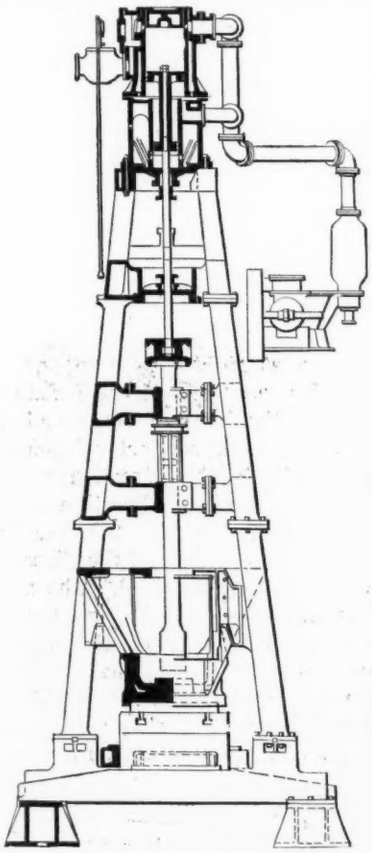


FIG. 7. SECTION THROUGH STAMP CYLINDERS

"What's the idea of using high-pressure steam? I thought you said the turbine was using steam from all stamps and from some auxiliary turbine."

"Sure, that is just what I said. There are times, however, when there will not be enough exhaust steam to operate the turbine with the load it may be carrying, and then there will be the necessity of admitting high-pressure steam to carry the remainder of the load.

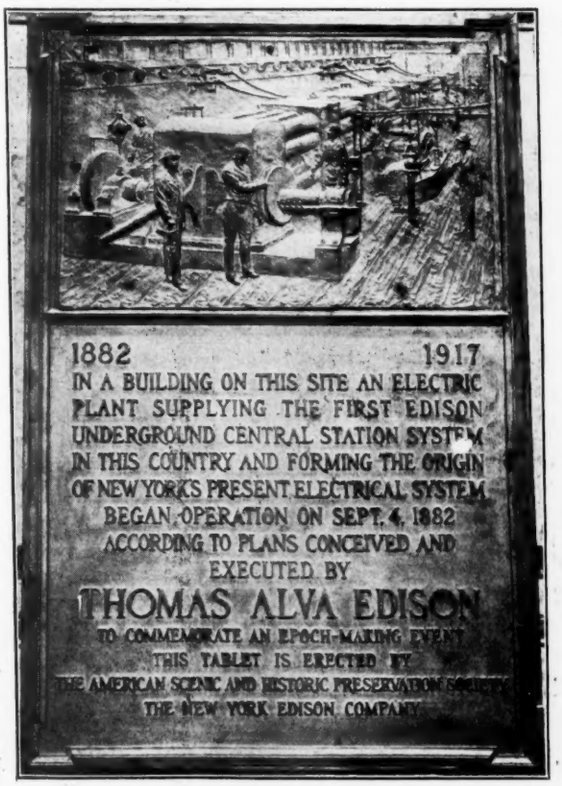
"If enough low-pressure steam is being supplied to the turbine to carry the load, the high-pressure blading runs idle. Just as soon as the load overbalances the exhaust-steam supply, which by the way may be very unsteady at times, live steam is automatically admitted to the high-pressure blading, or stages as it is called. The admission of high-pressure steam brings the turbine up to speed and keeps it there until the supply of low-pressure steam increases sufficiently to carry the load, when the high-pressure steam is automatically cut off and the turbine runs on low-pressure steam until the load again increases.

"To put it in a nutshell, the use of a mixed-pressure turbine is a newer method of compound than that used in reciprocating-engine practice, because the same result is obtained as when using steam in two or more cylinders and then discharging into a condenser. Now this turbine is simply placed between the exhaust line from the stamps and the condenser and uses the exhaust steam for making electricity, as I said before, as it goes to the condenser. Nothing could be more simple now that it is being done. In this particular turbine there is provided a high-pressure inlet valve that is under the control of the same governor that controls the low-pressure inlet and that automatically admits live steam to the turbine at such pressure and volume as is necessary to assist the low-pressure steam or to carry the load entirely."

From the power plant we went to the smelter, but in the main the process was the same as that described in a previous article.

New Edison Tablet for the Pearl Street Station Site

Exercises commemorating the thirty-fifth anniversary of the introduction of the incandescent lamp in New York and for the dedication of the bronze tablet which is to be placed on the site of the original generating station operated by Edison at 257 Pearl St., were held at the Grand Central Palace on Thursday, Oct. 18, in connection with the annual Electrical Exposition.


1882 1917
IN A BUILDING ON THIS SITE AN ELECTRIC
PLANT SUPPLYING THE FIRST EDISON
UNDERGROUND CENTRAL STATION SYSTEM
IN THIS COUNTRY AND FORMING THE ORIGIN
OF NEW YORK'S PRESENT ELECTRICAL SYSTEM
BEGAN OPERATION ON SEPT. 4, 1882
ACCORDING TO PLANS CONCEIVED AND
EXECUTED BY
THOMAS ALVA EDISON
TO COMMEMORATE AN EPOCH-MAKING EVENT
THIS TABLET IS ERECTED BY
THE AMERICAN SCENIC AND HISTORIC PRESERVATION SOCIETY
THE NEW YORK EDISON COMPANY

BRONZE TABLET WHICH WILL MARK SITE OF FIRST EDISON ELECTRIC POWER HOUSE IN NEW YORK

Thomas Alva Edison was invited to be present, as were also the men who were with him during the construction of the original station.

Borough President Marks accepted the invitation of the American Scenic and Historic Preservation Society to make an address. Other speakers on the program were Dr. George F. Kunz, the president, and J. W. Lieb, president National Electric Light Association. Arthur Williams, general commercial manager New York Edison Co. and president of the Electrical Exposition, presided.—*Electrical World.*

One thing is certain—the power plant engineer does not take kindly to by-product coke for fuel.

The Electrical Study Course—Fundamental Principle of the Dynamo

The basic principle of the electrical generator is discussed, and some of the laws governing the generation of an electromotive force by a conductor moving across the field of a magnet are considered.

SO FAR in our studies we have considered only the production of an electromotive force as generated in a battery cell by electrochemical action and by thermal action on the junction of two dissimilar metals. The most important method, and the one upon which the successful application of electricity today depends, is what is called electromagnetic induction—the principle discovered in 1830 by Michael Faraday at the

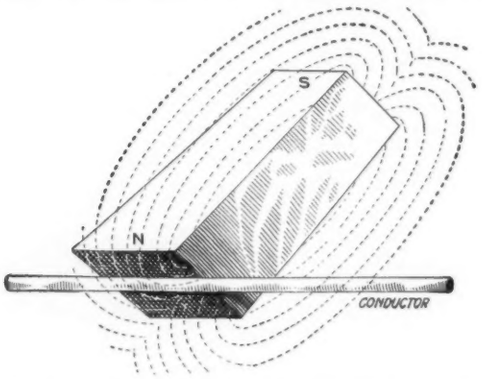


FIG. 1. CONDUCTOR IN MAGNETIC FIELD

Royal Institution, London, England—that an electric pressure is set up in a conductor when it is moved across the field of influence of a magnet.

This principle is illustrated in Fig. 1, where a magnet is shown with a conductor located in its field of force. If the conductor is moved upward or downward across the lines of force at right angles to them, an electric pressure will be set up in the conductor, and if its two ends are closed through another conductor, an electric current will flow. It does not make any difference whether the conductor or the magnet is moved as long as there is a relative movement of the conductor through the magnetic field not parallel to the lines of force.

Fig. 2 shows the general idea embodied in the first dynamo used by Faraday. The device consists of a copper disk supported so that it could be revolved between the poles of a horseshoe magnet. Brushes rest on the shaft and the periphery of the disk, so that when the disk is revolved a current of electricity flows through the circuit. This is the principle upon which all dynamo-electric machinery is constructed at the present time. It has been almost ninety years since Faraday made this discovery, that when a conductor is moved across a magnetic field an electromotive force is generated in the former, yet with all the effort that has been given to finding out why this is so by hundreds of scientists, the question still remains unanswered. Although we do not know why an electromotive force is produced in a conductor when it is moved across a magnetic field at right angles to the lines of force we understand the laws that govern the generation of an electric pressure by this means and are therefore able to design very efficient electrical machinery.

The direction of the electromotive force as generated in a conductor cutting the field of a magnet depends upon the direction of the lines of force and the direction and motion of the conductor. There are a number of rules for determining the direction of the voltage when the direction of the lines of force and that of the conductor are known, but the one shown in Fig. 3 is about the simplest, most convenient and chiefly used. This method consists of placing the thumb and first two fingers of the right hand at right angles to one another, as shown in the figure. Then if the forefinger points to the direction of the lines of force and the thumb the direction in which the conductor is moved, the middle finger will indicate the direction of the voltage or current. In the figure the direction of the current flow or voltage will be to the left. If the motion of the conductor is reversed as in Fig. 4, the direction of the voltage or current will be reversed. The same would be true if the motion of the conductor were the same as in Fig. 3, but the polarity of the magnet changed; that is, the direction of the lines of force changed. If both the direction of the motion of the conductor and the lines of force are changed, the direction of the electromotive force will not be changed.

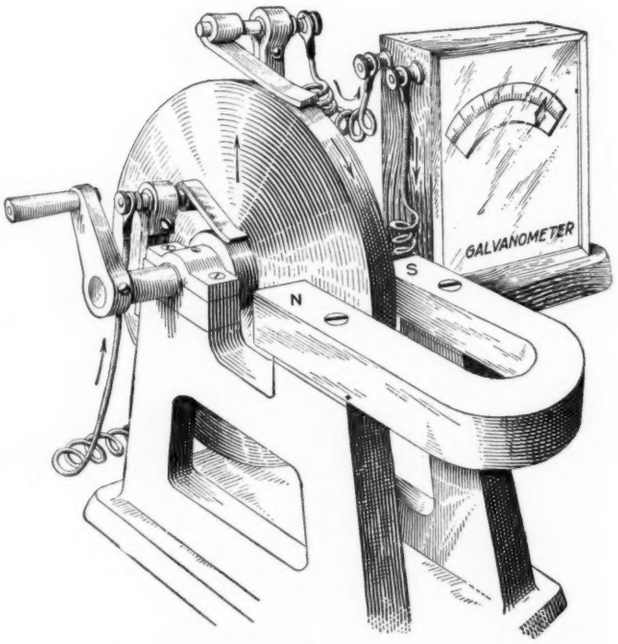


FIG. 2. ILLUSTRATING PRINCIPLE OF FARADAY'S FIRST DYNAMO

For example, taking Fig. 4 as the original condition, then Fig. 5 shows the condition when the direction of both the conductor and lines of force have been changed. It is seen that the forefinger points in the same direction in both cases, or in other words, the direction of the voltage is the same under both conditions. From

this the deduction may be made that in order to reverse the direction of the electromotive force generated in a conductor, it is necessary to change the direction of motion of either the conductor or the lines of force, but not both.

In the lesson, "Elements of Magnetism—III," in the Jan. 30 issue, it was pointed out that the term "lines of force" is only figurative, because in the true sense, or at least as far as we know, such a thing as a definite line does not exist. Therefore, the lines which are generally shown in pictures of magnets are used only to indicate that there is a flow of "something" from the N to the S pole of the magnet and the direction of the flow. If the like poles of two magnets are placed one centimeter, approximately one-third inch, apart, as shown in Fig. 6, and they repel each other with a force of one dyne, the magnetic field is said to be of unit strength. This unit is known as the centimeter-gram-second (c.g.s.) unit and is equivalent to $\frac{1}{445{,}000}$ lb.

Therefore, one line of magnetic force is just what the term would imply; namely, a force, just as one fan blowing against another creates a force which would tend to separate them. To express the magnetic unit more accurately, when two magnets of equal strength, of 1 sq.cm. cross-section each, are placed 1 cm. apart in air and repel each other with a force of one dyne, they are said to be of unit strength.

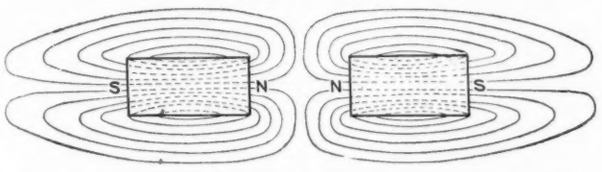
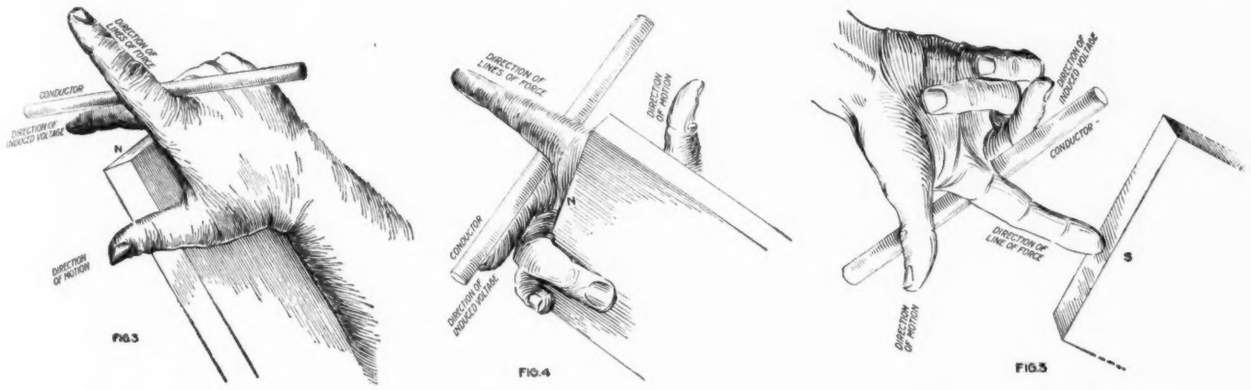


FIG. 6. SHOWS REPULSION BETWEEN LIKE POLES

Taking a magnet having a field of unit strength, that is, one line of force per square centimeter, and moving a conductor through this field at a uniform rate so that it will cut across it in one second, there would be generated in the conductor what is called a unit electromotive force. In other words, if a conductor cuts one line of force per second, it will generate a voltage of unit value. This unit has never been given any other name than unit electromotive force. It is a theoretical unit and is used only in establishing the relation between it and other electrical and magnetic theoretical units.

The value of this theoretical unit of voltage is so small that it would be very inconvenient to use in practice, and to get a unit for use in practice 100,000,000 of these theoretical units are combined into one and called a volt. Expressing this another way, when a conductor cuts 100,000,000 lines of force per second, at a uniform rate, it will have one volt of electric pressure generated in it.

Right here is where we should distinguish between the number of lines of force cut and the rate at which they are cut. It is not necessary for a conductor to move for one second and cut 100,000,000 lines of force at a uniform rate in that time, in order that one volt be generated in it. If such were the case, it would have one volt generated in it during the period of one second. On the other hand, if the conductor was in motion for only one-hundredth of a second and cut 1,000,000 lines of force, it would have generated in it one volt, the same as when cutting 100,000,000 lines of force in one second—the rate of cutting is the same in both cases. From this it is seen that all that is necessary to generate one volt is for the conductor to cut the lines of force at a rate equivalent to 100,000,000 per second. This might be called the starting point in the design of all dynamo-electric machinery.



FIGS. 3 TO 5. RIGHT-HAND RULE FOR DETERMINING DIRECTION OF VOLTAGE GENERATED IN A CONDUCTOR CUTTING LINES OF MAGNETIC FORCE

In problem 1 in the last lesson the circuit was 750 ft. long and used 350,000-cir.mil. conductors; 230 volts was available at the load when 175 amperes was being transmitted. The volts drop in the line, in this problem, is $E_d = \frac{21.4DI}{\text{cir.mils}} = \frac{21.4 \times 750 \times 175}{350{,}000} = 8$. The volts E at the source of power equal the sum of the volts E_a at the load and the volts drop E_d, or $E = E_a + E_d = 230 + 8 = 238$. Resistance of the line is $R = \frac{E_d}{I} = \frac{8}{175} = 0.045$ ohm. Figuring another way, the resistance of the line will be the resistance of 1500 ft. of 350,000-cir.mil conductor; referring to the wire table, this size conductor will be found to have a resistance of 0.03 ohm per 1000 ft., or $1.5 \times 0.03 = 0.045$ ohm per 1500 ft. The total watts W supplied to the system are equal to the total volts E times the total current I, that is, $W = EI = 238 \times 175 = 41{,}650$; watts loss W_l in the line equals the volts drop E_d times the current I, or $W_l = E_dI = 8 \times 175 = 1400$; the watts W_a supplied to the load are equal to the volts E_a at the load times the current I; hence, $W_a = E_aI = 230 \times$

175 = 40,250, and the sum of the watts lost and those supplied to the load should be equal to the total watts, or $W = W_l + W_a = 1400 + 40{,}250 = 41{,}650$. This checks with the first method.

The second problem was: A set of 48 lead cells is to be charged by direct connection to a 110-volt line. The electromotive force is 1.9 volts each at the beginning of charge, and at the end of charge 2.28 volts each. If the resistance of each cell is constant at 0.001 ohm throughout the charge, what will be the charging current at the beginning of charge; and near the end of charge when the voltage has reached the value stated? Make a diagram to show the connections.

Since in this problem the 48 cells are connected in series, the total resistance of the battery will be the resistance of one cell times the number of cells in series,

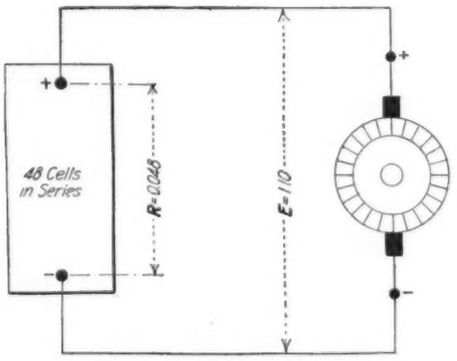


FIG. 7. SCHEMATIC CONNECTIONS FOR CHARGING STORAGE BATTERY

or in this case, $0.001 \times 48 = 0.048$ ohm, and the voltage E_b of the battery, that of one cell times the number of cells in series, or at the beginning of the charge $E_b = 1.9 \times 48 = 91.2$ volts. Since the battery voltage opposes that of the generator when charging, the difference between the generator voltage E and battery voltage E_b will be effective in setting up a current through the cells, or $E_e = E - E_b = 110 - 91.2 = 18.8$ volts. Now, 18.8 volts is available to cause a current to flow through the battery resistance of 0.048 ohm, then by Ohm's law $I = \frac{E_e}{R} = \frac{18.8}{0.048} = 392$ amperes, which equals the current flowing through the battery at the beginning of charge. At the end of charge the voltage of each cell has increased to 2.28 volts, then the total voltage of the battery is $E_b = 2.28 \times 48 = 109.44$, and the effective voltage E_e to cause the current to flow through the battery is $E_e = E - E_b = 110 - 109.44 = 0.56$ volt. Under this condition, the current flowing through the battery is $I = \frac{E_e}{R} = \frac{0.56}{0.048} = 11.7$ amperes. Fig. 7 shows the connections for charging the battery.

The armature of a dynamo has a resistance of 0.0175 ohm, is connected through 1250 ft., total length, of 250,000-cir.mil. conductor to a load that has 1.13 ohms resistance. Find the voltage generated in the armature when supplying 225 amperes to the load, the volts at the armature terminals, the volts at the load, and the volts drop in the line, volts drop in the armature, watts supplied to the load, watts loss in the armature, watts loss in the line, and the total watts.

Chart for Flow of Steam

By J. B. Kommers
Assistant Professor of Mechanics, the University of Wisconsin

On the opposite page is an alignment chart for Babcock's formula for the flow of steam in pipes,

$$W = 87\sqrt{\frac{CPD^5}{L\left(1 + \frac{3.6}{D}\right)}}$$

in which

W = Weight of steam delivered, in pounds per minute;
C = Density of steam at pressure used;
P = Pressure drop, in pounds per square inch;
D = Actual inside diameter of pipe, in inches;
L = Length of pipe, in feet.

In order to make the use of the chart more convenient, it has been calculated on the basis of the actual inside diameter, but the nominal diameter has been indicated on the chart. For the same reason, instead of plotting density, the scale on the chart shows the absolute pressure per square inch.

The most frequent use of the formula is for determining the diameter D, the other four variables being known. The key diagram shows the use of the chart for this case.

Sometimes it is desired to calculate the weight of steam W, the other variables being known. For this case the procedure is as follows: Connect L and P and determine a point on X; connect this point with the proper value of D and get a point on Y; connect this point with the proper density C and read off the value of W.

Sometimes the drop in pressure P is the unknown variable wanted. In this case connect W and C and determine a point on Y; connect this point with the proper value of D and get a point on X; connect this point with the proper value of L and read off the value of P.

Corrosion in pipes varies with the conditions of service to a great extent, according to the size of pipe used, its thickness, the quantity of water used, its temperature, etc., and there is even a difference in corrosive effects as between different parts of the piping in the same building. It has been conclusively shown in hot-water systems that the corrosion in hot-water lines gradually decreases with the distance from the boiler, and that corrosion is more severe in horizontal lines than in vertical lines conveying either hot or cold water. The piping in buildings close to a pumping station is probably subject to more severe corrosion on account of the larger amount of free oxygen in the water, and the quantity of water flowing will, to a certain extent, influence corrosion, for the larger the quantity the more abundant will be the amount of oxygen available for corrosion. It might, therefore, be assumed that corrosion will vary to a great extent according to the size of the building. Contrary to expectations, however, it was found that the life of the pipes was on an average no shorter in the large buildings than in the small ones, this being undoubtedly due to the fact that the sizes of the pipes are proportioned to the requirements, the large buildings having large mains, with heavier walls, affording a greater resistance to corrosion.—*Thomas F. Payne.*

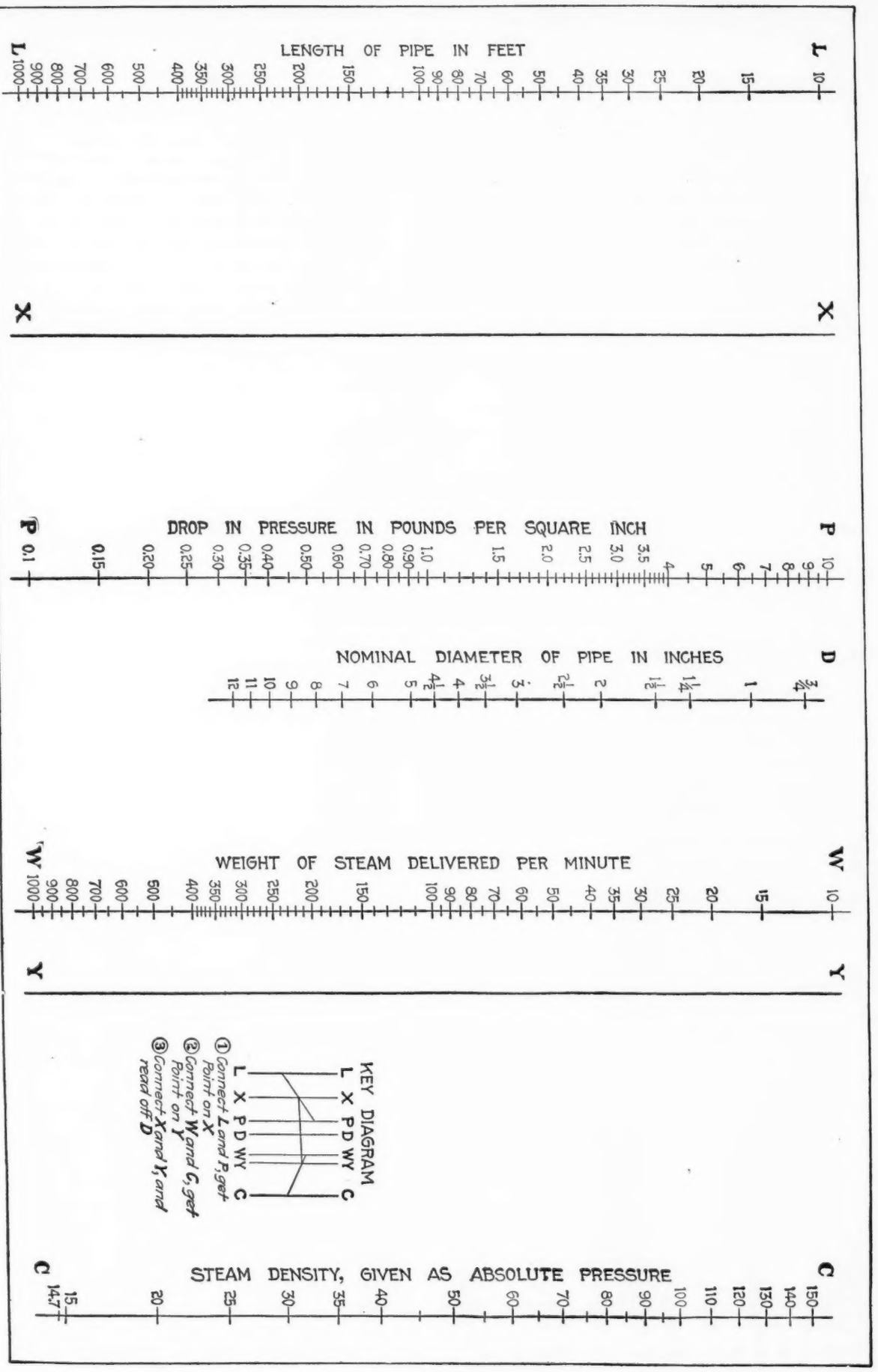

LENGTH OF PIPE IN FEET
L
X
DROP IN PRESSURE IN POUNDS PER SQUARE INCH
P
NOMINAL DIAMETER OF PIPE IN INCHES
D
WEIGHT OF STEAM DELIVERED PER MINUTE
W
Y
KEY DIAGRAM
L X P D WY C
① Connect L and P, get Point on X
② Connect W and C, get Point on Y
③ Connect X and Y, and read off D
STEAM DENSITY, GIVEN AS ABSOLUTE PRESSURE
C

CHART SHOWING THE RELATIONS OF LENGTH AND DIAMETER OF PIPE, RATE OF STEAM FLOW AND LOSS OF PRESSURE

The Possibilities of Peat as Fuel

By John Olsen
Consulting Engineer, Arlington, Mass.

With the increased cost of coal and the uncertainty of obtaining it, it seems but natural that some attention should be given to the possibility of developing other sources of fuel which may be available for industrial purposes. Among such are the peat deposits, which cover large areas in the United States and Canada in regions remote from the coal fields, and frequently near industrial centers, where they may be utilized without rail transportation or by a comparatively short transmission line.

Peat is used as a fuel in Europe for nearly all purposes for which coal may be used and is produced in increasing quantities every year, a number of industrial plants depending on it for their fuel supply. In America little has been done to utilize peat for fuel, though it is used for a number of other purposes.

It seems probable that in the United States the field for peat is not so much for domestic purposes as for power or as an industrial fuel, to be utilized near its source. It is particularly well adapted for use in gas producers or for burning in suspension in powdered form.

The old method of preparing peat for fuel by hand labor is obsolete. To be successfully done it must be accomplished by machinery simple in construction and operation. Its use in powdered form simplifies its preparation greatly, as it may be collected and conveyed to storage almost entirely by machinery. For this purpose cableways, electric scrapers, tractors, industrial cars and suction collectors have been used. To be used in gas producers the peat should run about an inch in size with only a limited amount of "fines." Even for this purpose it may be prepared and collected largely by machinery, but requires more labor than when collected for use in powdered form.

Dewatering Without Artificial Heat

The main problem in peat production is the dewatering of it without the use of artificial heat except such as may be available from other processes. In its natural state peat contains about 90 per cent. water and even a well-drained deposit will run nearly 85 per cent. This cannot be extracted by any mechanical means devised up to this time. It can be done by exposure to the air or by artificial heat; but as the latter process may be demonstrated mathematically to require as much fuel as it makes available, the method of preparing peat for fuel is limited to air-drying. This is evidently a season process confined to certain months in the year, as a rule not exceeding six or seven, out of which must be deducted for bad weather probably one-third. During the season a sufficient quantity must be accumulated to meet all demands until next season, for unless a continuous supply is assured it cannot become an industrial fuel. But notwithstanding the factor of uncertainty attached to air-drying, it is possible to obtain a certain minimum amount from each acre, which will be increased materially during a favorable season. With a well-selected drying field this minimum amount should be about 500 tons containing a moisture of 30 to 35 per cent. A great deal depends on the ability of the man to obtain the maximum benefit from the drying action of the sun and wind and the least damage from the rain.

For gas-producer use peat should contain not more than 30 to 35 per cent. moisture, but for use as powdered fuel it should be dried as low as possible and contain not over 15 per cent. It is not possible to air-dry with any certainty to such a low moisture, and for this purpose the drying must be completed artificially, using for this purpose waste heat if available. The amount of fuel required for drying peat from 35 to 15 per cent. moisture is less than 8 per cent. of the fuel produced. This should not be done until immediately before the fuel is to be used, as peat dried below a certain limit reabsorbs moisture from the air; this limit depends on the humidity of the air and may be as high as 25 per cent. For use as powdered fuel the fiber, if any, should be screened out, but there need not be any waste as it may be marketed without difficulty.

Use of Peat in Gas Producers

The Canadian government has made a series of experiments on the use of peat in gas producers, demonstrating its value for power and other purposes. Peat containing 30 per cent. moisture was used, and for each pound used (calculated on a moisture-free basis) from 49 to 53 cu.ft. of gas was produced with a calorific value, when leaving the producer, of 6030 to 6310 B.t.u. The peat used contained about 7 per cent. ash. The results obtained are confirmed by European practice.

Powdered peat has been used for some time in Europe as a fuel and is reported to give a higher efficiency than other fuel—75 per cent. efficiency for peat against 64.2 per cent. for Newcastle coal. The calorific value is given as 7400 B.t.u. for peat containing 12 per cent. moisture, and 1.4 ton equal to one ton of coal in heating value. It is difficult to see why powdered peat should not be as well adapted for industrial purposes as powdered coal or better. It will burn without producing slag; it is light in weight and should remain in suspension better than coal; it fires at a lower temperature and requires less air for combustion. It will not develop gases if moist and should be safer in operation than powdered coal. Some difficulty may be assumed in grinding it until a grinder for that particular purpose has been developed. Moisture-free peat containing 10 per cent. ash will average about 60 per cent. volatile matter and 30 per cent. fixed carbon, but varies considerably. The ash content may be as low as 3 per cent., but a peat with 10 per cent. is considered of good quality; deposits running 10 per cent. or less are quite common.

Cost of Producing Air-Dried Fuel

One can only roughly estimate the cost of producing air-dried fuel in the United States. It is largely a question of climatic conditions. While numerous attempts have been made and in the aggregate large sums of money have been spent on producing peat fuel during the last fifty years, little information is on hand as the processes involved were mostly experimental and based on pressing, briquetting or other mechanical means or on some form of artificial drying, all of which might have been foreseen to result in failure. To a people with a mechanical turn of mind air-drying seems

primitive, but the fact remains that in Europe every year millions of tons are produced, often under conditions not unlike those in the United States. The Canadian government conducted a few years ago a series of experiments at its experimental plant in Ontario, producing several thousand tons and reported a cost of $1.65 per ton of air-dried peat of 25 per cent. moisture, including allowance for interest and amortization. At the present time the cost would of course be much higher, and it is doubtful if it can be produced in the United States now for less than $3.50 to $4 per ton in quantities of 5000 tons or more per season. The possibility of using it for fuel would mainly be determined by a comparison with the cost of soft coal. Where this is selling for $6 per ton or more, it seems worth while to investigate what may be done with peat if it can be obtained without rail transportation, and where coal is worth $8 per ton or more, rail transportation or transmission lines might be possible.

Hints on Ammonia-Compressor Lubrication

By E. W. Miller

It would seem reasonable to expect that an engineer that prides himself on the small amount of oil used in the steam cylinders of his engines would apply the same reasoning to the cylinders of his ammonia compressors. The reverse is, however, the case in a large number of plants, and upon inquiry the operator as a general rule has no specific reason for doing so except that it has been the regular practice and no one has suggested a change.

Oil in the condenser or expansion coils of a refrigerating plant is just as detrimental as oil in a boiler. While not an element of danger, as in the boiler, it reduces the heat-absorbing capacity of the pipes or coils so that the efficiency and capacity of the system are greatly reduced. I have seen a few cases where the capacity of the system was increased nearly 50 per cent. by thoroughly removing the oil from a badly loaded system.

Compressors Get Too Much Oil

The average ammonia compressor as a general rule gets too much oil. An ammonia compressor works under different conditions from those under which an engine or air compressor works. In the steam engine fresh steam is admitted to the engine at every stroke and the exhaust steam carries a large amount of the oil away with it. The same thing takes place in an air compressor. An ammonia compressor, however, works on a closed system, and after it has been in operation for some time, traces of oil circulate around the system, and ammonia is itself slightly lubricating, so that practically very little, if any, additional oil is required for the compressor cylinder. Vertical double-acting machines are about the only exceptions to this rule, as the oil from the stuffing-box as well as that carried around in the suction gas all goes to the lower end of the cylinder and the top will run pretty dry. A small hand pump connected to the top suction so that a small quantity can be squirted in at this point about once every two hours will serve the purpose and, together with what is carried into the lower end from the stuffing-box and the suction gas, will provide all the lubrication required. A half-pint per 24 hours injected into the machine in this manner for a 100-ton unit should be sufficient.

For vertical, single-acting units and horizontal machines there is no need of pumping oil into the cylinder. There is probably enough carried around in the average system to be sufficient for the compressor. In addition, there is considerable oil carried into the cylinder by the piston rod from the stuffing-box oil lantern, and some is also carried into the suction line by the gas escaping through the gas relief line from the stuffing-box. The net result is that practically all the oil used is passed through the compressor cylinder and sometimes in considerable quantities. The practice of many operators, to shoot in an extra quantity into the compressor, is consequently a waste of good oil and a detriment to the whole system as well as doing no real good.

Oil Lantern in Stuffing-Box

The average ammonia compressor is provided with an oil lantern in the center of the stuffing-box, and a large number of horizontal machines have an additional oil gland in front of the stuffing-box. The gland at the front is often provided with an oil pump which circulates a continuous stream of oil through the gland at all times. In this case but little oil is required for the oil lantern at the center of the stuffing-box.

In many plants only an oil cup is provided for the front gland, and in this case the oil lantern will require a little more oil. A pint to a quart per 24 hours, depending on the size of the machine, is ample.

The feed on the front gland, if the machine is provided with one, can be a little more liberal, as this is mainly utilized in lubricating the rod and packing at the front end of the stuffing-box. A large part of it drips off at the stuffing-box, and if provision is made to catch this, it can be used over again for other machinery or mixed with the regular lubricating oil for general use. In this way none of the oil will be wasted while insuring liberal lubrication of the rod and packing, which is practically all that requires extra oil in an ammonia compressor.

If a good grade of packing is used and the rod is kept in good condition so that the packing need not be run excessively tight to prevent leaks, and the packing is renewed before it gets too old and loses its resiliency, but little oil will be required for this purpose and there will be no trouble from the packing cutting or scoring the rod.

Oil Trap Should Be Blown Out Regularly

Close attention should be given to the oil trap in the discharge line, and this should be blown out regularly. The frequency with which it should be blown down depends on the size of the trap and the amount of oil used. A large trap on a small system, where little oil is used, will obviously not require blowing out as often as a small trap on a large system. In the first case twice a month would be sufficient, while in the latter once a day might be necessary to keep the trap clear. The trap should never be allowed to get so full as to decrease its effectiveness; probably half full is as high as any oil trap should be allowed to fill. A lot depends on the construction of the trap. One can readily tell the height

of the oil in the trap by placing the hand on the trap; it will be quite cold to the point where the oil level is, and above this it will be considerably warmer. Blowing out is not to be recommended unqualifiedly, as a little ammonia is always blown when the last of the oil comes out, and this causes a waste of ammonia.

The temperature at which a compressor is run has much to do with the quantity of oil used. If the machine is run cold, very little or no oil is needed. If the discharge is hot, more oil will be required. To determine the proper amount, take out the discharge valves and inspect the cylinder once in a while. If the valves work freely and there are no signs of wear, and the cylinder is smooth, the supply is ample. If there is an excess of oil present, the amount used should be cut down. Many large plants never use a drop of oil in the ammonia cylinders; only a small sight-feed cup over the rod is used, the same as one generally sees on an engine rod packed with metallic packing. No oil is used for the oil lantern, but a connection is made to the liquid line so that liquid can be injected into the lantern when the stuffing-box gets warm. In this manner the stuffing-box is never allowed to get hot.

Quality of Oil Important

Only the best grade of oil, particularly adapted for the work, should be used in an ammonia compressor. The ideal oil for this work should keep the same consistency at all temperatures. It should not congeal at the lowest temperatures to be met with in regular operation, and it must not vaporize at the highest. The best ice-machine oils are a compromise between these two extremes. On low-temperature systems the temperature will vary from about 20 deg. F. below zero to sometimes 300 deg. above. If the oil does not have a low congealing point, it will congeal in the expansion coils at this low temperature and stick to the walls of the coils like paraffin or lard when it solidifies. This forms an excellent insulation where it is not wanted. On the other hand, if the oil has a low flash point it will vaporize at high temperature, forming a foul gas in the condenser. It also reduces the capacity of the compressor by increasing the reëxpansion at the beginning of the suction stroke.

To test the oil, draw off a small amount of ammonia into a cup or small can and into this place a small glass or anything else convenient, with a sample of the oil to be tested in it. The temperature of the boiling ammonia will be about 28 deg. F. below zero and that of the oil practically the same. If the oil will stand this temperature and still remain fluid, it is good as far as low temperature is concerned. Next put a small sample of the oil in a can or other vessel and slowly raise the temperature to about 300 deg. If the oil does not vaporize at this temperature, there will be no trouble from this source in the system.

Electrical insulations made from ordinary fibrous materials of a cellulose nature or base will stand about 95 or 100 deg. C. without becoming too brittle to be durable. However, the same materials when treated with suitable varnishes or gums apparently stand temperatures of about 105 deg. C. without undue deterioration mechanically.

Some Early Voltage Regulators

By Leon L. Pollard

Engineers of the present day do not realize to what expedients the first electric power station men resorted to keep things moving, as the machines naturally were operated under difficulties and conditions were not all that could be desired in the way of speed and voltage regulation. When the street railways began to change over from horse cars to electric power, there was naturally a lot of confusion, as the equipment was entirely new to most of the managers, as well as to the men, and it was quite a problem to keep the cars

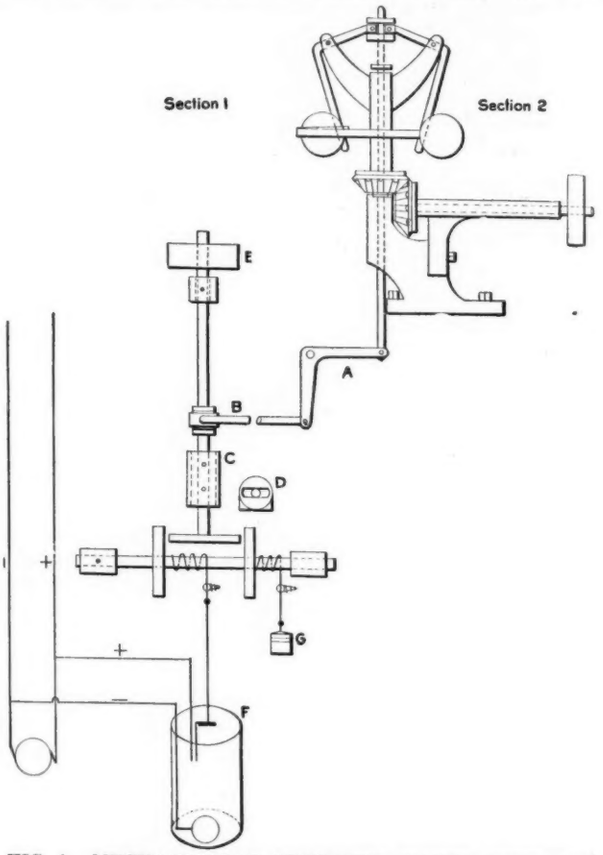


FIG. 1. MECHANICALLY OPERATED WATER RHEOSTAT

moving, especially where waterwheels were used, the waterwheel governor not having been perfected. The power house at Fairfield, Me., was built in 1891, and electricity supplanted the horse cars.

No satisfactory waterwheel governor could be procured, and although the load was fairly steady (there was but one car on the line), it took most of one man's time to tend the gate and the voltage on the line would vary considerably. It therefore became necessary to get up some kind of voltage regulator, so the following described device was built, being in fact a mechanically operated water rheostat.

The illustration for the most part is self-explanatory. The Waters governor was attached to a bell crank *A*, Fig. 1, from which a rod *B* extended to a small shaft supported by two boxes, the one at *C* being fitted with a slot as at *D*, which allowed the shaft to move sideways about ¼ in., under the control of the governor.

The shaft was driven by a small belt at *E*, and on the opposite end a leather-covered disk revolved between

two made of iron, and as it touched either of the iron ones the friction would of course cause the latter to revolve. The rope wound around the shaft between the iron disks was attached to a large movable terminal at the end of a flexible cable extended to the positive side of the generator, and a weight *G* counterbalanced the weight. A plate was put in the bottom of a barrel and a wire extended from it to the negative terminal of the generator. The barrel was filled with water, to which sulphuric acid was added to increase its conductivity. When starting up the generator, the terminal *F* was lowered into the barrel far enough to create an artificial load, and water was turned on the wheel to bring the voltage on the generator up to normal.

When the cars started, the lowering of the speed would of course affect the governor, which in turn would cause motion to be transmitted to the disk which would wind up the rope, attached to the terminal *F*, pulling the electrode up, thereby letting the generator speed up, which would of course raise the voltage. When the cars stopped pulling, the operation would be reversed. The first trouble that occurred was because no stops had been provided and as the speed dropped the disk to raise *F* was caused to revolve, as it should, but there being no stop, it kept on winding up the rope and tried to wind the flexible cable and all around the shaft; but the friction wheel could not carry the load, and it slipped and allowed *F* to drop back. A screw-eye and a knot prevented the rope from winding up too far, and it was tried again. It went up all right, but when the speed went down, the central disk engaged the other disk, and no stop motion having been provided, it acted the same as the other one had—unwound and wound up in the opposite direction, resulting in a fine case of racing. So another screw-eye and knot were used on the rope that ran to the counterweight to prevent over-travel in that direction, and the terminal was then kept within bounds; when either knot came in contact with the screw-eye, the friction would slip, preventing further travel.

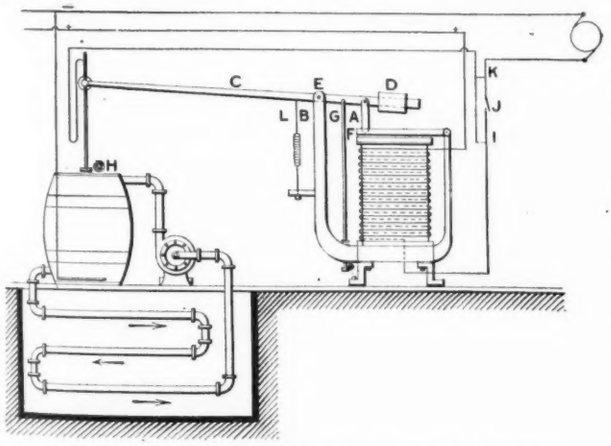


FIG. 2. MAGNETIC OPERATOR AND COOLING COIL

Considerable trouble was caused by the water in the barrel boiling away, and new water had to be constantly added to make up the loss and the whole station was filled with steam. When a cover was made to fit over top of barrel and a pipe run to the outside of station one would think there was a small steam engine running. The action of the steam and sulphuric-acid fumes quickly rotted the cover and a new one lined with lead was made, but it formed a short-circuit between the two leads at the top of the barrel and was burned up.

During cold weather someone suggested heating the place with the steam issuing from the barrel. Iron pipe being too expensive for the experiment, common "down spout" pipe was procured and a radiator made from it that worked satisfactorily for a short time, then filled with water and burst.

After numerous other "minor" troubles, and being unable to make the regulator work satisfactorily, a new scheme was thought up: The water rheostat principle was retained, but the operating device was different, being an electromagnet.

Magnetic Control and Water Circulation

As so much trouble was caused by the rapid boiling away of the water, and as another car was to be added to the equipment of the railroad, a small rotary pump was connected up as shown in Fig. 2. A coil of pipe was put in the flume where it would be under water at all times, and a pipe led from the bottom of the barrel to the coil and from the coil to the suction side of the pump used to circulate the water from the barrel through the coil and back to the barrel. The rest of the apparatus worked as follows: A magnet 12 in. high and 6 in. in diameter, and wound with No. 0 wire, with a plate 6 in. in diameter and ½ in. thick, furnished the power to operate the lever as shown. As the long end of lever *C* was 3½ ft. long and the short end only 3½ in., a slight movement of the plate would cause considerable movement at the long end, giving quite a wide range of resistance between the two electrodes. A stop motion in the form of a small rod was put on this time to prevent the plate traveling too far in either direction. At first the positive wire was attached between the circuit-breaker and the generator with the result that when the breaker "kicked" out, the generator promptly ran away, as there was nothing to prevent it because the opening of breaker cut off the line to which the water rheostat was connected. This was changed to the generator side of breaker, after which it worked satisfactorily.

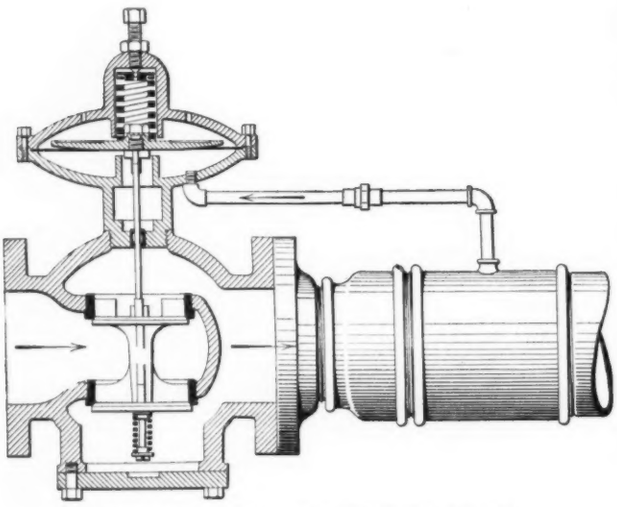
The operation of the regulator was as follows: When the generator was started, the movable electrode was pushed down and enough water was turned on the wheel to bring the voltage up to normal, the rheostat being able to take care of 125 amperes. When the cars started to take current, the current flowing through the magnet connected in series with the generator would energize the plate on top, drawing it down and it would pull the terminal up, letting the current that was being consumed in the barrel flow to the line.

When the cars stopped taking current, the action was of course reversed, the rheostat taking care of the current. If the cars were still drawing 50 or 75 amperes, the magnet would not be so strong and would move the plate only a short distance. If the foregoing had worked out as planned, it would have been all right, and it did very well, although it would sometimes hold the plate down too long and send the voltage too high.

This regulator was used about four years, when one of the now well-known oil-pressure governors was bought, being the second one shipped into Maine.

Simplex Pressure Reducing Valve

There is nothing new in a reducing valve that is controlled by means of a diaphragm, and such a valve is being made by the G. E. Witt Co., 862 Howard St., San Francisco, Calif. What they have aimed to do, however, is to produce a simply designed valve that will be practically frictionless and one that will work equally well on steam, gas, air or a liquid. A sectional view of the valve is shown in the illustration.



SECTION THROUGH REDUCING VALVE

One of the principal features is the absence of packing. In order to prevent leakage between the valve body and the diaphragm chamber, a small valve stem that passes through a close-fitting bushing is used.

In order to take the strain from this small valve stem when the valve seats, a spring is used below the valve disks. The only strain, therefore, is that due to the compression of this spring. An adjusting spring is placed above the bronze diaphragm plate, and the adjustment for the reduction of the pressure is obtained by increasing or decreasing the tension of this spring.

Regulation is most satisfactorily obtained if the reducing pressure for operating the diaphragm is taken at a distance from the reducing valve. The valve is fitted with a gauze strainer to protect it from scale and dirt. It is designed to hold the reduced pressure constant even though the initial pressure may fluctuate and in installations where it is being used, a steam pressure of 125 lb. is reduced on the distributing lines to from 1 to 5 lb., holding the lower pressures constant.

Extinguishing Oil Fires

The following letter, contributed by C. R. Weymouth to the Bulletin of the Industrial Accident Commission of the State of California is reproduced here in full:

I have just read with interest the *California Safety News* for August regarding flarebacks of oil fires, and am glad to note that you are giving this subject the needed attention.

On page 5 is the statement, "An oil fire cannot be extinguished by the use of water. Sand, steam or a chemical fire extinguisher must be used." I believe this statement should be qualified somewhat.

The most disastrous tank explosion in the experience of our company was at the plant of the Pacific Light and Power Co., at Redondo, Calif., in 1908. By the failure of the owners to apply padlocked manhole covers a careless operator, owing to failure of the electric-lighting circuit, put a lantern into the tank to observe the height of oil. An explosion and fire resulted, which nearly caused the death of four men, all four being badly burned and disabled for some months. The first man was injured as a result of the explosion, the other three were injured by an attempt to put out the fire by turning steam into the tank. The result of this was to force the oil vapors out of the tank into the atmosphere, where they ignited, causing a second explosion and conflagration.

A steam blowout pipe to a tank should have its handle removed and should not be used in case of a fire. It should be used only after the tank has been emptied and when the operator desires to go down into the tank, the steam expelling the oil vapors and gases before entering tank. In so far as possible devices should be provided for the observation of the height of oil in the tank and temperature of the tank without unlocking the manhole cover; and when auxiliary tanks are so provided, dangers will be minimized.

While we have had no direct experience with chemical extinguishers, from the experience of others—when properly applied—results are satisfactory.

The above is sent merely as a result of our general interest in the good work which you are doing.

Wire-Rope Manufacture

According to *Lubrication* the manufacture of wire ropes appears to have originated in Germany about the year 1821. During this year ropes of the salvagee type were made for the Geneva Suspension Bridge, and shortly afterward stranded wire ropes were manufactured. Wire-rope manufacture in England dates from about 1838, this year marking the invention of a rope machine by R. S. Newall, of Dundee, who later established the wire-rope works from which has arisen the vast wire-rope industry of England and later that of the United States.

It is customary to furnish wire rope of one-size wire construction, but there are two ropes made of three-size wire. One, known as Warrington Lay, has seven inside wires of uniform diameter surrounded by twelve alternately large and small wires. The metallic cross-sectional area is thereby increased by approximately 10 per cent. with correspondingly increased strength. In the other three-size rope, Seal Lay, the center wire is large and is surrounded by nine smaller wires which are, in turn, surrounded by nine wires of the same diameter as the center one. This style of rope has proved to be especially durable where extreme abrasive action was experienced and has been successfully used on slopes and also on cable roads where there were no sharp bends to flex the outside wires.

Pure mica will stand high temperatures, such as 700 deg. C. Good grades of asbestos will stand at least 400 deg. C. as shown by actual test and possibly very much higher.

Editorials

Dye Works and Central-Station Power

IF THERE is any business in the wide, wide world that can successfully operate its own steam plant, it is a dye works. Large volumes of steam are used for heating water, dye vats and for drying purposes—the power demand being comparatively small.

There could be two pertinent reasons to influence the purchase of power—a large and sudden increase in the volume of business such as to bring the output of the works beyond the capacity of the steam plant, or the serious crippling of the generating machinery.

It was with surprise and with more than passing interest that we learned, through a weekly news letter issued by a large engineers-managers company which operates a number of central stations, that one of the largest dye works in Reading, Penn., had been won over to central-station service. Ye Gods! If a dye works cannot compete with central-station rates, then there is but little hope for the isolated plants of thousands of other industries holding out against their seductive propositions.

The item is as follows:

> The Metropolitan Edison Co., of Reading, Penn., has secured a contract for supplying power to the Prospect Dye Works, one of the largest establishments of its kind in the city.
>
> This is especially interesting to the electric industry generally. The greater portion of steam generated by dyeing establishments is utilized for commercial purposes, only a small portion being required for power. Now that it has been found advantageous to replace this small portion required for power with electricity, a new field for power is opened.
>
> The Prospect Dye Works is the fourth large Reading industry to become a new power customer within the past few weeks.

Looks like a knockout, pure and simple. It looks, on the face, as if there were no reasons why other dye works throughout the country should not shut down their engines and purchase electrical energy. With the knowledge that a plant with use for large quantities of heat can produce power cheaper than the central station will sell it, we were intensely curious to ascertain what conditions could exist that would influence the dye works to purchase central-station energy. We went; we saw. No mystery, just common business sense of a business man was responsible for the utilization of purchased energy—the opening up of this new field for selling power.

Why the change from steam engine to electric motor? Because the engine was partly wrecked, that is all. With the power end of the establishment down, the generator that furnished energy for the motors in the works was of course useless. What other course would an intelligent business man follow than to obtain the quickest power possible; to purchase electric energy in order to keep his works in operation until the engine could be put back into operation? That is what was done in this instance.

The situation at the dye works is substantially as follows: The engine, of about one hundred and fifty horsepower, has been in operation approximately fifteen years. Three weeks ago the crank broke about midway between the crankshaft and the crankpin with the result that other parts of the engine were more or less damaged. Arrangements were immediately made with the electric company to tap its power lines and supply energy to two motors—one to drive the direct-current generator formerly belt-driven by the engine and another one that is located in the works, both totaling about the same power as that formerly produced by the engine. According to information obtained at the works the present arrangement is to tide over a breakdown period.

It is worth while to note the difference between present and former operating conditions. With motor drive the energy expended in turning the generator can be used for no other purpose. When the engine was in operation, the exhaust steam was used for heating water for boiler feed and other purposes. Under such conditions the engine was operating as a reducing valve, and the power necessary to generate electrical energy cost practically nothing during periods when all the exhaust steam was used.

Will the monthly power bill show in favor of returning to steam drive? We think it will. Shavings are used in considerable quantities for firing the boilers, of which there are two of the vertical type. These shavings are obtained from a shop in the city proper at a rate, we understand, around three and one-half dollars per carload—about what it would cost for loading and freight charges. This fuel is supplemented with some coal. With such cheap fuel and the loss of the heat units in the exhaust steam, the probabilities are strongly favorable for the return to the old engine stand-by when the chickens in the shape of power bills come home to roost, and the expiring contract permits.

Direct-Current Generators Without Commutators

IN MECHANICS perpetual motion has been for ages the "will-o'-the-wisp," and incalculable human effort and millions of dollars have been wasted upon these schemes and from all indications will continue to be wasted. In spite of the fact that the law of conservation of energy proves that perpetual motion is an absolute impossibility, hundreds of individuals are willing to disregard this established truth and continue to waste their time, energy and money upon this age-long fallacy.

In electricity, although it cannot boast of the ancient ancestry of perpetual motion, there is a "will-o'-the-wisp" in the form of high-voltage direct-current generators without commutators or a multiplicity of collector rings, which has as many devotees as perpetual motion ever had—at least the number of requests received by technical papers and engineers throughout the country

regarding the possibility of this type of apparatus and to make analysis and report on schemes of the foregoing nature would indicate such to be the case. Engineers and scientists who have given this problem serious attention have recognized certain fundamental reasons why high-voltage direct-current generators without commutators or collecter rings cannot be built, and this conclusion is today accepted by engineers in general; nevertheless, this scheme has not lost any of its attraction for many of the ill-informed.

B. G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Co., in the *Electric Journal*, May, 1915, expressed the following opinion on high-voltage direct-current generators without commutators: "This problem may be compared, in some ways, with the perpetual-motion fallacy. A perpetual-motion scheme may be made so complicated and may involve so many principles and combinations that it is very difficult to put one's finger on the real fallacy; yet, if the law of conservation of energy is brought to bear upon it, the details of the scheme need not be considered at all, for this one fundamental law condemns it utterly, regardless of methods or means involved. In the same way, in the direct-current machine without a commutator, certain fundamental principles of flux cutting and electromotive-force generation are sufficient to condemn all machines of this sort, regardless of their type or construction. In the final analysis they usually come down to one effective conductor, or turn, per pair of collector rings, which is the well-known unipolar generator. However, the fundamental principles are difficult to make clear to the inexperienced, just as it is hard to convince some people that the law of conservation of energy holds good over the whole finite scale, from the practical standpoint. Therefore, the writer anticipates passing upon such schemes in future, just as he has done for some twenty-five years past, and he, coincidentally, will be obliged to dampen many bright hopes of aspiring inventors."

The most pitiful part of this proposition today is that most of those who attempt the development of this type of apparatus are not familiar with the simple fundamental principles involved or what has been done in the way of developing machines of this character. Many of the schemes generate an alternating current when the would-be genius believes his device produces a direct current. In other arrangements the voltage generated in one-half of the conductor is neutralized by that in the other half, and others again are nothing more or less than the unipolar type of machine. In the early part of 1900 this latter type of generator was exploited by two of the largest electrical manufacturing companies in this country, and several machines of this type were built and put into operation; but after machines had been developed up to as large as two thousand-kilowatt capacity, the type was abandoned on account of certain fundamental difficulties that could not be overcome. In reference to the development of the unipolar machine, Mr. Lamme once said that "the saying, 'Happy is the country which has no history,' may be paraphrased in the electrical-manufacturing business into 'Happy is the company which has no unipolar history.'"

The days when the development of electrical equipment was more or less of a guess and cut-and-try method, and most everybody's guess was about on a par have long gone by. At the present time those who are not familiar with at least the fundamental principles with which they are dealing had better leave the development of new types of electrical equipment to those who are, and turn their attention to some other pursuit that will be beneficial to themselves and to the community, and quit wasting their time and energy, as well as that of others, upon something they know nothing or very little about.

Stop the Waste

IF YOU had only five tons of coal in your cellar and knew that it would take ten tons to get you through the winter, and no more was to be had, you would not start your furnace in September and run it recklessly, opening the windows instead of shutting the drafts when it became too warm.

The country is short of coal or, rather, the labor to mine and cars to transport and distribute it. Work essential to the winning of the war is hampered by the lack of fuel. Yet New York streets are lighted in broad daylight, and huge electric signs are consecrated to the nonessential blazoning of Wabbly's Chewing Gum and Glen Guzzle Whisky. Those whose interests are served by the continuation of this waste decry any movement in the direction of economy, declaring that the extinguishing of the lights will result in gloom and pessimism, in the interference with the "business as usual" propaganda, and that the amount of coal consumed in maintaining the Great White Way is infinitesimal. The latter argument will be interesting to those who are paying the bills, and the entire condition deserves the attention of those who are paying three prices for their coal.

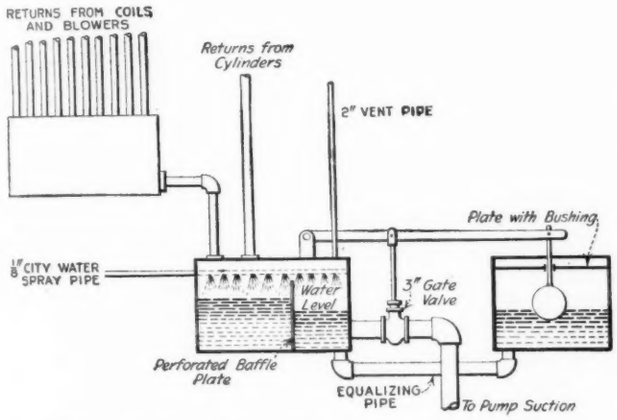
The cost of running the thousands of lights which are burned unnecessarily may be insignificant, but the cost to the average householder of running a few extra bulbs overtime makes a very significant difference in the monthly account rendered. We are glad to see that United States Fuel Administrator Garfield has made a positive move toward restricting this waste, and hope his order will be complied with without disparaging criticism. The sooner we realize that we are at war and begin to live accordingly, no matter whose pocketbook is hit, the sooner we shall have it over.

Brigadier General Crozier, chief of the Bureau of Ordnance of the War Department, says that the mobile artillery of the new army will require by September, 1918, at least 22,000,000 gallons of toluol. At the present time we are producing about half of this quantity annually from byproduct coke ovens, but most of this is under contract for the Navy and our allies. The only additional source immediately available is by stripping illuminating gas. Taking out a gallon from every twenty thousand feet would yield about 11,000,000 gallons, and even greater stripping would be necessary to make up the quantity needed. Rather than have our army suffer for high explosives, the American people will without a grumble use poorer gas or even sit in the dark. But if the people give up their toluol to the gas companies for nothing, will the gas companies pass it on to the Government at the cost of recovery?

Correspondence

Return Piping from Drying Coils

The following may be of interest to those who have to take care of the returns from large heating or drying systems. In our case there were six machines having a total of 6430 sq.ft. of indirect and 1380 sq.ft. of direct radiating surface, and three blowers with a total of 3335 sq.ft. of surface. Our first attempt at returning the condensate was draining the system, at 40 lb. pressure, into a large nonreturn trap, thence into a return trap and into the boilers. (The drying cylinders, being under only 1 to 5 lb. pressure, were discharged into a hot-water tank.) This caused constant water-hammer in the coils from the start, and



SATISFACTORY ARRANGEMENT OF RETURN PIPING

when a leak began, it could not be repaired until the end of the week, and as these machines were on an upper floor, losses were caused by the leaks running through the floor, spoiling material on the floor below.

Our next attempt was an improvement, as we placed a steam trap on each set of machine coils, one on each set of drying cylinders and one on each blower coil. The discharge from each trap was led into a receiver and from there delivered into a return trap above the boilers. This return trap was calibrated and found to discharge 143 lb. of water each time it dumped and it sometimes dumped four times in five minutes, making about 6860 lb. per hour, which is pretty severe service. This arrangement worked very nicely as long as the return trap was in good order, but in a short time it began to give out frequently and this meant bypassing to the sewer until it was repaired. Our final attempt, giving the best results, was to trap and pipe each machine, cylinder and blower individually into a receiver and from there into a large closed tank, as shown in the illustration. This tank has a baffle plate to steady the level of the water and beyond it is connected a small circular open tank containing a float. There is a small cold-water spray pipe placed near the top, to condense the vapor. The return comes from the receiver into the closed tank and from there down a 3-in. pipe to the boiler-feed pump, which discharges through a heater into the boilers. In the 3-in. pipe there is a gate valve operated by the float, which always maintains a water seal, so there will be no trouble from the pump taking air.

By this means we take care of all the return water without waste, and there has not been, in the last four years, the slightest trouble from leaks and our drying rooms have from 15 to 20 deg. higher temperature than previously.

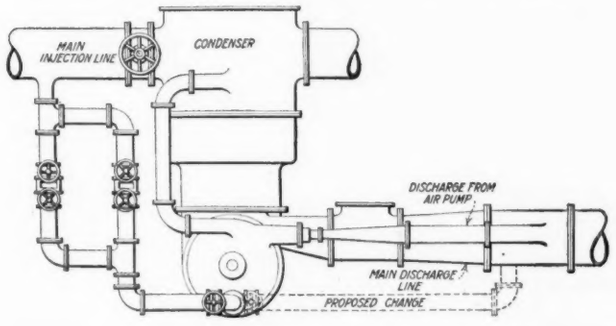
GFORGE H. HANDLEY.

Newburgh, N. Y.

Will Change in Water for Air Pump Be Good or Bad?

The following is written for the purpose of securing the views of engineers who may read it. The letter relates to proposed changes in the condenser-water supply for a steam turbine, and the objections to the change as advanced by the manufacturer.

The turbine is a semidouble-flow type, 10,000-kv.-a. capacity at 1800 r.p.m., with steam at 160 lb. gage, and equipped with a Leblanc condenser and air pump. The air and removal pumps are driven by a turbine of the noncondensing impulse type, running at 640 r.p.m. The water supply is from a canal and is carried to the condenser through a 24-in. pipe provided with the usual injection valve. Immediately adjacent to and on the supply side of this valve is a tee facing downward, from



DOTTED LINES SHOW PROPOSED CHANGE IN PIPING

which a 10-in. line drops down through a pair of duplicate strainers, thence along the floor to the air pump on the opposite side of the condenser.

An idea of the installation can be had from the accompanying illustration, in which no attempt at actual reproduction or drawing to scale has been made. The dotted lines represent the proposed change.

The two principal objections to the installation as it is at present, are:

1. The inability of the pump turbine to take care of the full amount of water that the turbine demands when running at its maximum capacity. This condition

is somewhat aggravated by the necessity of the pump raising the water to a common discharge line located approximately ten feet above the discharge nozzle.

2. The presence of slush ice in the condensing water during severe cold weather. This ice obstructs the flow of water through the strainers to the air pump to such an extent that at times it is almost impossible to keep the unit on the line because the operator cannot clean the strainers as rapidly as they fill up.

We shall consider the two objections jointly, since the one change was supposed to remedy, or at least assist in eliminating them. Briefly, the idea was as follows: Instead of taking an extra supply of water from the injection line to supply the air pump, it was proposed to take it from the main discharge line at a point between the removal pump and the air-pump discharge line, so as not to draw in any discharged air.

The valve on the air-pump supply line is run about seven turns open the year around with temperature variations in the condensing water amounting to 75 deg. F. The main injection valve is run about five turns open at full load. It can readily be seen that by utilizing this discharge water as a supply to the air pump, just this amount can be added to the condensing water at the main injection valve and still maintain the same load on the pump turbine. Of course, no trouble could be experienced from slush ice after the water has passed through the condenser.

It was thought best to consult the manufacturer before making the changes, so a sketch and letter of explanation were sent. In their reply they said that they would not recommend the change on the following grounds:

That owing to the increased temperature of the discharge over the injection water (approximately 30 deg. F.) the efficiency of the air pump would be reduced about 50 per cent., and that the air-pump supply should be taken from a point as near the main injection valve as possible.

Frankly speaking, I do not know just why this is. Neither do I understand why the efficiency of the air pump should be reduced 50 per cent. by increasing the temperature of its supply water 30 deg., when an increase of 75 deg. F. does not seem to affect it.

If my ideas are wrong, I would like to be enlightened, and I will appreciate a discussion of the subject.

Cincinnati, Ohio. L. F. FORSEILLE.

The A. S. M. E. Boiler Code in Indiana and Michigan

In *Power* for Oct. 30, on page 597, you give a map of the states that have adopted the A. S. M. E. Code.

You are mistaken when you say that Indiana has adopted a code. It has not even taken any steps in that direction. Indiana has a boiler law of its own, and under certain conditions of construction of the Code boiler, it would be forbidden use in Indiana under the Indiana laws. W. M. TAYLOR.

Indianapolis, Ind.

[Statute 344, Approved Mar. 8, 1915, entitled "An Act providing for certain safety appliances to be used on steam boilers; providing for the construction, inspection and installation of such boilers, and providing for the enforcement of the provisions of this Act and fixing penalties for the violation thereof, provides in Section 10 that 'boilers built to the standard of the American Society of Mechanical Engineers as issued by direction of the council of the American Society of Mechanical Engineers, Feb. 13, 1915, will be acceptable to the State of Indiana.'" Indiana, therefore, may be included among the states in which this Code is in force, although it was perhaps a trifle strained to say that it had been adopted by that state.—Editor.]

In the Oct. 30 issue of *Power* there is an article on page 596, in which Michigan is listed as one of the states having adopted the Boiler Code of the American Society of Mechanical Engineers.

We are not aware of any boiler law having been passed by this state, and if you know of such a law and will cite it to us, the courtesy will be very much appreciated. There have been bills introduced at the last two or three sessions of the legislature, but so far as we are informed they all failed to pass.

PORT HURON ENGINE AND THRESHER CO.,
Port Huron, Mich. H. E. Hall, Secy.

[The bill known as the Hanley Act, from the name of its introducer, was approved by the Governor on May 3, 1917. It provides for the establishment of a Board of Boiler Rules, similar to those of Massachusetts and Ohio, and that board has been appointed, consisting of E. W. Bissell, professor of engineering at the Michigan Agricultural College, East Lansing, chairman; C. G. Christensen, professor at the Michigan School of Mines, at Houghton, secretary; E. C. Fisher, mechanical engineer of the Wickes Boiler Co., Saginaw, vice chairman; J. C. McCabe, of Detroit, chief inspector; and Sheridan Milan, of Grand Rapids, representing the operating engineers. The act provides that "This Board shall gather statistics of causes of steam-boiler explosions and formulate rules and regulations for the safe operation, use and construction of steam boilers. The rules and regulations so formulated shall be substantially in conformity with the Boiler Code of the American Society of Mechanical Engineers."—Editor.]

Suggested Designs for Centrifugal Machinery

I note with interest the "steam motor" appearing on page 529 of the Oct. 16 issue. If it is to be considered radical to depart from the old standard practice of mounting two machines upon a sub-base, making use of a flexible coupling, why would it not be still more logical to do away entirely with the sub-base with its planed surfaces, using, instead, flanges between the two machines, with radial machined surfaces, which are easily machined at right angles with the longitudinal bore of the machines? With the use of a male and female fit, perfect alignment is assured.

To advance a step farther, why not do away with the third bearing, leaving, in this instance, the prime mover entirely overhung, standard flanges and drilling to be adopted to suit the standard horsepower ratings of the prime movers? This, of course, in lieu of the fact that the pump or blower, as the case may be, has one manufacturer and the prime mover another, which leads one

to ask why we have not more manufacturers who build the complete units, making it in most cases possible to assemble the working parts of both into one integral casting? Therefore, with few exceptions two bearings only are necessary, with none of the disadvantages of trying to assemble two machines together.

With the adoption of the turbine-driven centrifugal pump and blower, why not make them in standard capacity sizes and to an adopted United States standard design, this standard to be arrived at by the manufacturers or the engineers? Should the manufacturers not desire to enter into a standard design, why not invite the engineers to offer such designs, the most meritorious details of each to enter into some part of the United States pump or blower, as the case may be?

Dallas, Tex. C. E. PRATT.

Publicity About Turbine Accidents

In correspondence relative to the article, "High Speed of Steam Turbines," *Power*, Oct. 2, 1917, W. F. Schaphorst says that "turbines which have exploded due to overspeed or overpressure in the lower stages have been very few and far between." It is of importance to the profession to know that the records show that many accidents due chiefly to these causes have occurred. The following is a list of some turbine accidents.

STEAM-TURBINE ACCIDENTS AND LOSSES

Atlantic Mills, Providence, R. I.: Small tool left in machine. Stripped the blades all around. Loss not heavy except for delay.

Binghamton Light, Heat and Power Co., Binghamton, N. Y.: Shaft sprung and blades stripped. Damage not serious except for the delay.

Boston Manufacturing Co., Waltham, Mass.: On Mar. 31, 1915, a steam turbine at this plant exploded. Loss is estimated at between $4000 and $5000. One man was slightly injured by this explosion, which was due to excessive steam pressure in the turbine case.

Brooklyn Rapid Transit Co., Brooklyn, N. Y.: Small piece of rotor jammed and broke outside case. Escaping steam fatally scalded several men.

Cleveland Electric Co., Cleveland, Ohio: Turbine exploded. Details not ascertained.

Commonwealth Edison Co., Chicago, Ill.: 10,000-kw. turbine, generator case distorted, shearing off 2-in. bolts and wrecking electrical end of the machine.

Consolidated Gas, Electric Light and Power Co., Westport Power Station, Baltimore, Md.: On Aug. 30, 1913, the 7500-kw. Curtis vertical turbine exploded. It would appear from the information at hand that the atmospheric valve failed to relieve the pressure on the exhaust side. This caused excessive over-pressure, resulting in the turbine explosion. The entire unit was wrecked, together with a portion of the building, and five persons injured. Loss estimated at about $175,000.

Edison Electric Illuminating Co., Boston, Mass.: Supply of oil to step bearing cut off and rotor damaged. Amount of damage unknown.

Federal Mining Co., Flat Rock, Mo.: 750-kw. generator completely destroyed. Complete loss of turbine, generator and building.

Havana Central Ry. Co., Havana, Cuba: Entire machine thrown up and out of its bearings and to one side.

Hudson River Power Co., Utica, N. Y.: Wrecked from overspeeding; loss, $25,000. A second accident of the same kind six months later completely destroyed the machine; loss at least $75,000.

Illinois Traction Co., Riverton, Ill.: On July 20, 1911, the rotor of a steam turbine exploded at this plant, the result being two persons killed, two injured, and property damage estimated at between $40,000 and $50,000.

Inland Steel Co., Chicago, Ill.: Explosion of turbine in 1913 or 1914.

Lewiston Water and Power Co., Lewiston, Idaho: Main shaft deflected and stripped blades. Entire rotating part had to be replaced.

Los Angeles Gas and Electric Co., Los Angeles, Calif.: Three turbines wrecked in one explosion. Loss estimated at $250,000.

Massachusetts Chemical Co., Walpole, Mass.: Piece broken out of rotor. Entire rotor replaced.

Monterey Electric Light and Power Co., Monterey, Mexico: Turbine exploded and had to be rebuilt. Cause and cost not ascertained.

Narragansett Co., Providence, R. I.: Blades stripped by foreign substance, supposed to have been carried over through steam pipes.

New York Edison Co., New York City: Two turbines exploded simultaneously. Loss reported at $75,000.

Niagara Falls Power Co., Niagara Falls, N. Y.: Large generator exploded from electrical disturbance and overspeed. Loss, $60,000.

Pacific Mills, Lawrence, Mass.: Blades stripped. Loss not serious enough for the enforced shutdown.

Pfister & Vogel Manufacturing Co., Milwaukee, Wis.: Small turbine exploded. Total wreck.

Port Huron Electric Co., Port Huron, Mich.: Generator exploded from over-speeding. Steam end entirely wrecked.

Savannah Electric Co., Savannah, Ga.: Accident shut down the plant for some time. Details not obtainable.

Scranton Electric Light Co., Scranton, Penn.: Turbine exploded from over-speed. One man injured.

Solvay Process Co., Waltham, Mass.: Turbine and generator entirely destroyed.

Tennessee Coal and Iron Co.: Explosion of steam turbine in 1913 or 1914.

United Electric Co., Springfield, Mass.: Stripped blades. Damages not otherwise serious.

United Electric Ry., Westport Power House, Gould St., Baltimore, Md.: Two large steam turbines exploded, the loss on one being $160,000; the loss on the other, $100,000. (This and the accident at the Consolidated Gas, Electric Light and Power Co. makes a total property loss at Westport, Md., for three turbine accidents of $435,000.)

Waltham Electric Light Co., Waltham, Mass.: Explosion of steam turbine in 1910 or 1911.

Waltham Gas Co., Waltham, Mass.: Small turbine, 500 kw., partly damaged; loss, $7000.

S. D. Warren & Co., Cumberland, Me.: Small turbine exploded. Amount of damage not ascertained, but said to be slight.

Washburn-Crosby Co., Minneapolis, Minn.: Turbine failed from overspeed. One man scalded.

West Blylston Manufacturing Co., Easthampton, Mass.: Stripped blades, making necessary entire reblading.

Yale & Towne Manufacturing Co., Stamford, Conn.: 500-kw. turbine wrecked. Data not obtainable.

On Jan. 25, 1913, the rotating field of a turbo-generator exploded at Trieste, Austria. This machine was insured by the Vienna Boiler Inspection and Insurance Co., and the damage was reported as very large.

The foregoing data are by courtesy of the casualty companies. C. H. CAMP,

The Strong, Carlisle & Hammond Co.

Cleveland, Ohio.

Draft Control by Stack Damper

It is generally admitted that a better boiler efficiency is obtainable in an oil-burning plant than in one using coal, principally because less excess air is necessary for the complete combustion of oil than of coal. But close regulation of the dampers is necessary with oil, because there is practically an uninterrupted passage for air into the furnace, there being no fuel bed to check its flow. In most plants the front damper or ashpit doors are used for air control, while the breeching dampers are left wide open. One excuse for this is that of safety, for if the breeching dampers were used and should accidentally be closed entirely, an explosion would be likely to occur; but the real reason usually is that of accessibility.

It is possible to so operate the breeching dampers as to guard against their accidental closing, and if a convenient means is provided for their operation, they will be used and much better efficiency obtained. It is

a fact that restricting the flow of air into the furnace at the entrance virtually converts the entire boiler setting into a vacuum chamber, thus stimulating infiltration of air, causing a reduction in efficiency.

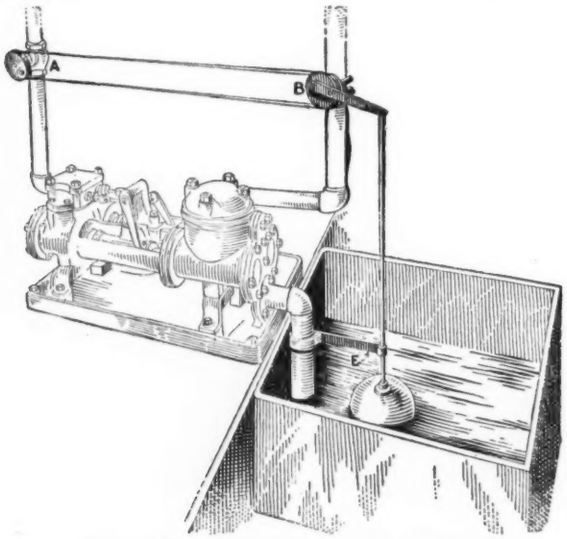
In one plant using the ashpit-door regulation, it was difficult to obtain 10 per cent. CO_2 at the top of the last pass (B. & W. boilers), so it was decided to provide a convenient means of operating the breeching dampers from the boiler front. The dampers were then kept in such a position that just enough air would be admitted to prevent smoke, and 15 per cent. CO_2 was often obtainable at the top of the first pass, and from 12 to 14 at the damper. This proved the advantage of this over the original method, and no explosions or other troubles have been experienced.

The dampers were originally held in position by a clamp on the rod and were so balanced as to be drawn shut by the draft when the clamp was removed. To overcome this the end of the lever was drilled and a weight secured to it heavy enough to drop the damper to full open when the clamp was loosened. A slender cable was secured to the lever and passed over two pulleys and so arranged that when pulled to its extreme limit the damper would still remain partly open and the clamp would have to be loosened as formerly to close it tight. The cable end was fastened to a lever at the boiler front, and the lever was clamped to a curved quadrant and held by a wing nut. For a change of damper position the wing nut was loosened and the lever moved up or down as desired. A similar or equivalent arrangement may be easily applied to almost any boiler, and its use is sure to be beneficial.

Del Monte, Calif. A. C. McHUGH.

Return-Pump Speed Regulator

The illustration shows how a float was connected so as to regulate the speed of a pump used to take care of the condensate from a number of sources and exceedingly irregular in quantity. Numerous modifications will suggest themselves, as conditions differ, but this seemed to be the best for ours. A wooden pulley about 3½ in. diameter, with a shallow groove, was fastened to the pump throttle *A*, and a similar pulley *B* 5 in. diameter was fastened to the pump discharge pipe, which happened to be conveniently located, and to this pulley an arm as shown. *E* is a guide for the float rod. The "belt" is made of ¼-in. belt lace given a double wind around each pulley to keep it from slipping. A stout cord might do as well. This rig has saved a lot of trips to regulate the pump by hand and the regulation is better, too. J. O. McDONNELL.



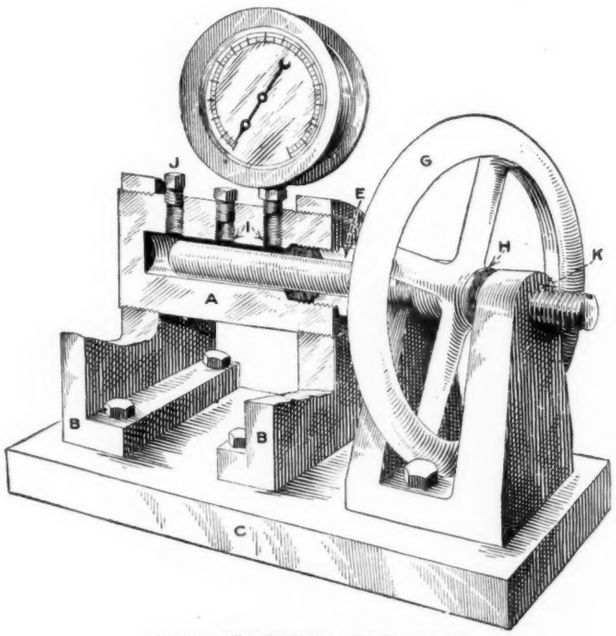
REGULATOR ATTACHED TO SUMP PUMP

Toronto, Ont., Canada.

Pressure-Gage Test Pump

Anyone using pressure gages knows how easily they get out of order, but with a tester it is easy at all times to ascertain their condition. I have found gages on high-pressure hydraulic work anywhere from 50 to 200 lb. out.

The illustration shows a pressure-gage tester which I built at small cost. It consists of a cylinder *A* made of solid machinery steel, bored to within one inch of the back end $\frac{1}{16}$ in. larger than the ram, and threaded inside, a short distance, to receive the gland *E*. The outside is threaded, on each end, to a snug fit in the supports *B*. Holes *I* are ½-in. standard pipe thread, and standard pipe bushings can be used to suit various gages. The hole *J* is threaded to fit the thread of a mercury column graduated to any desired pressure.



HIGH-PRESSURE TEST PUMP

The ram is threaded to fit a bronze bushing in the hub of handwheel *G*, which, when rotated, forces the ram into the cylinder, and while the handwheel is only 8 in. diameter, it is quite easy to produce a pressure of 5000 lb. The ball-bearing thrust washer *H* reduces the friction at this point. The whole device is mounted on a base *C* rigidly bolted and doweled. The stuffing-box is made to take three rings of packing, and having a fine thread, a tight joint is easily obtained. Key *K* prevents the ram rotating with the handwheel. When only one gage is to be tested, pipe plugs can be screwed into the openings not in use. C. M. ZUBLER.

Philadelphia, Penn.

Inquiries of General Interest

Reduced Steam Pressure No Advantage for Heating Liquids—We have four large open tanks that contain perforated lead-pipe coils that are supplied with steam at the full pressure of the boiler, for heating acid and water. When in use the draft of steam makes a hard pull on the boilers. Cannot the heating be performed just as quickly and with less steam from the boiler, if the pressure of the steam is reduced at the tanks from 100 to 50 lb. gage?

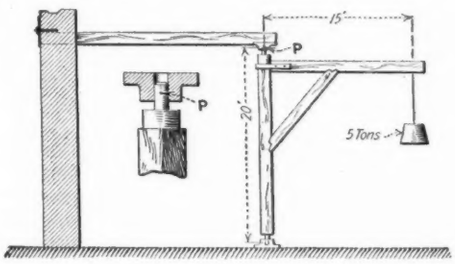
J. M. Q.

To perform the boiling in the same length of time, the heat of the steam needs to be supplied at the same rate, and the same quantity of steam supplied would have to be generated at the higher pressure, whether reduction of pressure is accomplished by throttling through a reducing pressure valve or solely from discharge through the perforations of the coils and absorption of heat by the liquid contents of the tanks.

Horizontal Stress on Center Pin of Crane—What horizontal stress would there be, at *P* in the sketch, due to a weight of 5 tons suspended at a horizontal distance of 15 ft. from the vertical axis of a crane 20 ft. high, measured between the middle of the bearings of the upper and lower center pins?

G. L. J.

As the horizontal lever arm of the weight is 15 ft., the moment or leverage of the weight of 5 tons would be 15 ×



5 × 2000 = 150,000 ft.-lb. moment. As the distance between the middle of bearings of the upper and lower center pins is 20 ft. and as, for equilibrium, the horizontal moment must be equal to the vertical moment, the horizontal stress at the center pins × 20 = 150,000; that is, horizontal stress = 150,000 ÷ 20 = 7500 pounds.

Striking Points on Engine—What are the "striking points" of an engine and how are they determined?

A. C.

Striking points are marks made on the guide of an engine to show where a special mark made on the crosshead would register with them if the connecting-rod was of such length that for a complete stroke of the piston it would just strike the cylinder head at the corresponding end of the stroke. To determine the location of striking points, disconnect either end of the connecting-rod and move the crosshead, piston rod and piston against the cylinder head at either end of the stroke. Then selecting any place on the crosshead that does not over-ride the guide, make a mark on the crosshead and a corresponding mark on the guide, and after moving the piston against the head of the other end of the cylinder, make a mark on the guide to correspond with the mark previously made on the crosshead.

Striking points thus located with reference to a mark on the crosshead are useful for readily determining the amount of piston clearance obtained at each end of the stroke after keying up the connecting-rod, by placing the engine first on one dead-center and then on the other, provided no change has been made in adjustment of the length of the piston rod, thickness of the piston or inward projection of the cylinder heads.

Laying Up Boiler with Charge of Soda Ash—When our boilers are to be taken out of service, I fill them with water, put in five to six pailfuls of soda ash, build a slow fire to drive the air out of the water, then draw the fire and allow the boilers to stand in that condition until required for use. Is there a better method of loosening the scale and laying up a boiler?

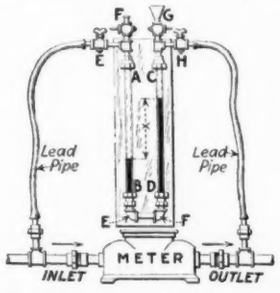
W. O. R.

There would be no certainty that the scale has been loosened up during the interval of rest, and by the method proposed the boiler and fittings are likely to become coated and corroded by long contact with the strong solution of soda ash. A better method would be to add two or three pailfuls of soda ash, fill the boiler nearly full with water and with a slow fire carry 5 to 10 lb. pressure for about 24 hours. Then wash out the boiler, clean the fittings and connections and repeat the boiling off and washing until the scale is removed. After cleaning, if the boiler is to stand ready for use at short notice, fill it completely with clean water and at firing-up time draw off the water to the proper working level; otherwise dry the boiler out and allow it to stand empty and closed up tight. Then before starting-up time it will be in best condition for removal of any scale that has to be dislodged by scraping or chipping.

Measuring Drop of Water Pressure—How can a gage be constructed and used for testing the loss of pressure of water in passing through a meter, valve or fitting?

S. R. B.

The loss of pressure can be tested by connecting the legs of a differential mercury U pressure gage to the inlet and outlet of the meter as indicated in the sketch. *AB* and *CD* are glass tubes of about ¼-in. bore and should have a length of about 2 in. per pound pressure per sq.in. that is to be measured, in addition to length required for connecting the ends of the tubes to ordinary glass-gage connections. The tubes are connected at their lower ends by a nipple and elbows *E* and *F*, but if practicable, it will be better to dispense with these fittings by forming *AB* and *CD* of a single glass tube bent in form of the letter U. The upper ends of the glass tubes are fitted with glass-gage connections and fittings as shown. With stop-cocks *E* and *H* closed and air cock *F* open, the tubes are to be filled about half-full of mercury through the funnel-cock *G*. *F* and *G* then are closed and *H* and *E* are opened, after which *F* and *G* are opened very slightly to allow escape of air from the upper part of the instrument. Greater pressure in the connection to the inlet side of the meter depresses the level of the mercury in *AB* and causes it to rise in *CD*. The difference of level of the mercury *X* will be due to the excess of pressure on the inlet side of the meter, assisted by a water column of the same height. As at ordinary temperatures the pressure due to a column of mercury 1 in. high equals about 0.491 lb. per sq.in. and that due to a column of water 1 in. high equals about 0.03609 lb. per sq.in., then, allowing a correction for the excess of pressure due to the column of water, the loss of pressure of the water in passing through the meter in pounds per square inch would be x inches × (0.491 — 0.03609) or $x \times 0.455$.



[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Development of the Turbo-Generator*

By RICHARD RICE
Chief Engineer, Steam Turbine Dept., General Electric Co., Lynn, Mass.

The developments of the Curtis type of steam turbine that have led up to the modern 45,000-kw. units of the present time are discussed, and the improvements in the efficiency and operating characteristics of modern power-generating equipment pointed out.

TURBO-GENERATOR design and construction have made tremendous strides in the last few years. The first Curtis turbines were made with several stages, each stage having as the rotating element a wheel carrying several rows of buckets. The bucket speed of such machines at first averaged around 325 ft. per second, the shaft speed being chosen with reference to the generator.

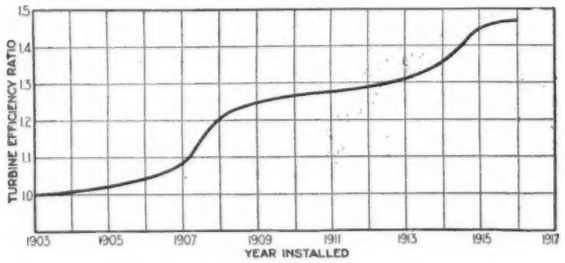


FIG. 1. INCREASE OF OVERALL TURBO-GENERATOR EFFICIENCY FIGURED ON THE RANKINE CYCLE

These earlier machines were crude when considered from the viewpoint of today, but they were of such economy in the use of steam as to hold their own with the apparatus then in customary use; while their first cost and operating cost were so much lower as to not only rapidly supersede all other apparatus for the same purpose, but, much more important, to lower the cost of electricity to the user and provide a great stimulus to the enlargement of existing power stations and the construction of new ones.

The advantages which were secured at the outset were enhanced as time went on by substantial improvements in efficiency and reduction in unit costs. These improvements may briefly be summarized as follows: (1) Increase of 47 per cent. in efficiency (Rankine Cycle), as shown in Fig. 1; (2) decrease in steam consumption of large-sized turbines, of 50 per cent.; (3) reduction in price per kilowatt of large turbines of 58 per cent. of the original unit's price.

This has been accompanied by a decrease in weight per kilowatt of 70 per cent. The largest unit built in 1903 was 5000 kw. It was found that the type lent itself readily to large unit construction, and in 1906, 8000-kw. units were made; in 1908 the maximum was 14,000 kw.; in 1911 it rose to 20,000 kw. per unit; in 1915, to 35,000 kw.; and now, in 1917, some 45,000-kw. units are building and will soon be in operation.

From the start, developments in quality and strength of material have played an important part. Often the production of a new turbine or generator has hinged entirely upon ability to procure material for bucket wheels of higher elastic limits or better elongation and reduction of area, upon the production of new bucket material, or otherwise; and it may be said without fear of contradiction that the turbines of today would be impossible with the materials of 1903.

The need for improved material has arisen from the use of higher bucket speeds or from the use of higher shaft speeds (made possible by improvements in generator construction), resulting from which and from increased number of stages there has been realized a higher bucket efficiency and a reduction in the windage losses.

The use of higher bucket speeds has been unjustly or ignorantly criticized in certain quarters by people who are not willing to recognize that the stresses in buckets and bucket wheels are actually calculable, are applied gradually, and in fact, as a writer recently said in London *Engineering*, page 182, Feb. 23, 1917 issue: "The stresses to which such wheels are subjected are nearly as steady as hydraulic pressure."

Bucket speeds of 700 to 800 ft. per sec., with existing materials, are much safer today than speeds of around 325 ft. per sec., used in the original turbines. As a matter of fact, the latter machines have always been better in an operative sense as well as in efficiency, and repeated improvements have increased their safety to a point not equaled by any other type of power-generating apparatus.

At the same time it must be recognized that this apparatus needs intelligent attention; and although this attention is less often required, still it is fully as important that it be provided. Emergency safety devices, however they may be constructed, will always be subject to accidental derangement, and periodic careful inspection is a necessity.

The direction of progress in the design of these turbines can best be seen from Figs. 3 to 6, which show the general assembly of the largest turbines that have been built, at various periods: Fig. 3, the 5000-kw. vertical turbine of 1903 (two-stage, four bucket rows per stage); Fig. 4, the 8000-kw. unit of 1906 (5-stage, 2 bucket rows per stage); Fig. 5, the 20,000-kw. horizontal unit of 1913 (9-stage, 2 bucket rows in first stage; remainder, single bucket row); Fig. 6, the 30,000-kw. horizontal unit of 1915 (12 stages).

Briefly, after abandoning the original type of many bucket rows per stage, the design settled down to the use of a number of stages, each having two bucket rows, with varying relations of the elements, up to 1912, when the use of single bucket rows per stage in all but the first stage gave another important impetus to the increase of efficiency. The progress since then has been in refinement of design and improvement in constructive details, but this progress has resulted in a decrease of over 20 per cent. in steam consumption since 1912. New units under construction, and even now operating, show appreciable gain in efficiency as compared with results mentioned.

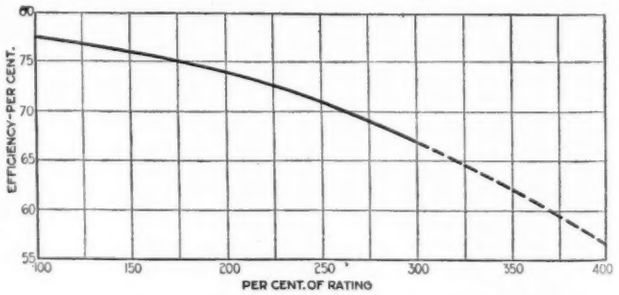


FIG. 2. EFFICIENCY CURVE 1500-HP. (NORMAL RATING) B. & W. BOILER, NOT INCLUDING ECONOMIZER

It is not generally understood, for instance, that the thermal efficiency of a turbo-generator plant for driving a steel mill suitable for operation in conjunction with four blast furnaces will be substantially equal to a corresponding gas-engine plant. In the table is shown the heat consumption of three plants of a size suitable for such an installation. The all gas-engine plant, in Column 1, is figured on an assumed efficiency of 20 per cent. to conform to the views of certain engineers familiar with the practical oper-

*Abstract from a paper, "Turbo-Generators," presented at the Eleventh Annual Convention of the Association of Iron and Steel Electrical Engineers, held in Philadelphia, Penn., Sept. 10 to 14, 1917.

ation of gas-engine plants. As, in this plant, the gas engines must take all the load variation and as gas engines rapidly fall off in efficiency with decreasing loads, owing to high fixed losses and unfavorable effects of variation in gas, it is believed that in this case, with all the variations of steel-mill loads to be expected in practice, the 20 per cent. would not be realized, and that this figure should be not to exceed 17 per cent.

Using 17 per cent. we have Column 2, which is believed by the author to show what is to be expected in the actual operation of such a station more nearly than Column 1.

The steam turbine, in sizes such as would be installed in a station of this magnitude, maintains its efficiency better than any other prime mover for varying loads. The efficiency assumed in Column 4 is not the maximum efficiency of such units, but is the efficiency that will be realized under the variable loads of steel-mill service.

This thermal efficiency has been achieved by improvements in turbines, generators, boilers, condensers and pumps, economizers, feed-water heaters, stokers and methods of operation, also by extending the heat range utilized in turbines, as made possible by these improvements in the direction of: Higher steam pressures, up to 300 lb. per sq.in., with higher pressures now about to be used; superheat up to 700 deg. F. final steam temperature; and vacuum to 29 in., easily obtainable and commonly obtained in central-power stations eight or nine months of the year by the use of surface condensers.

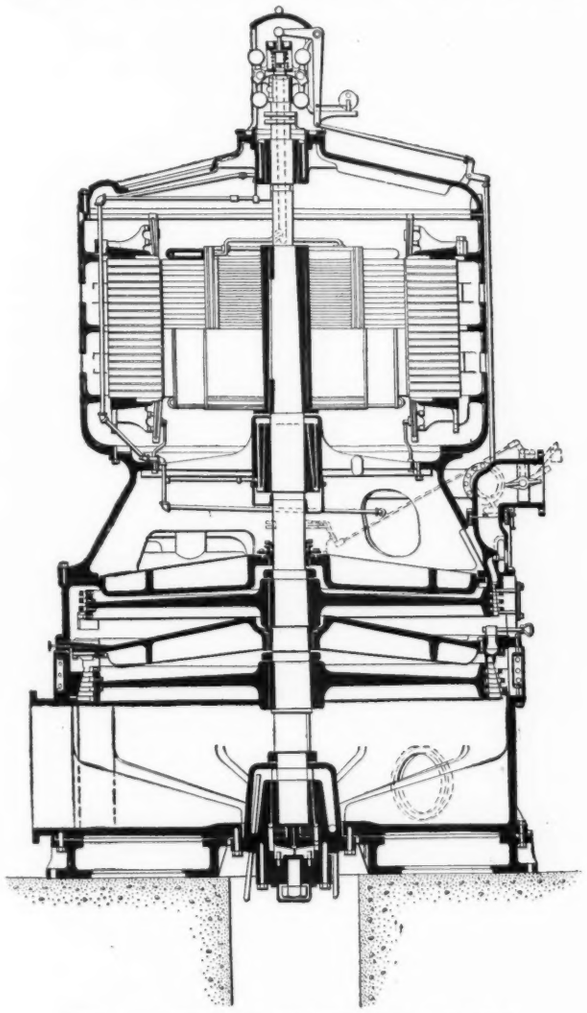


FIG. 3. ASSEMBLY 5000-KW. 1903 TURBINE

Improvements in steam boilers have resulted in a great increase in the capacity of units. It is now customary to use boilers rated as high as 2500 boiler horsepower per unit. This increase in size results in better combustion, secured by the larger combustion space thus obtained and by better disposition of the heating surface. The increased dimensions permit of increasing stoker capacity and of operation at excess of rating, as much as 100 to 200 per cent. with slight diminution from maximum efficiency. The maximum efficiency with coal firing for the boilers alone is over 77 per cent. in the best installations (Fig. 2). Such boilers are perfectly adapted to the use of blast-furnace gas, particularly if the gas is subject to the Cottrill electric-cleaning apparatus, and with such cleaning and good handling 75 per cent. efficiency should be readily obtainable in actual operation.

Economizers are coming into general use in central stations. They should be used in steel-mill plants also. They add from 4 to 6 per cent. to the thermal efficiency of the station and have been subjected to many years of development; they are easy to operate, low in maintenance, and entirely reliable.

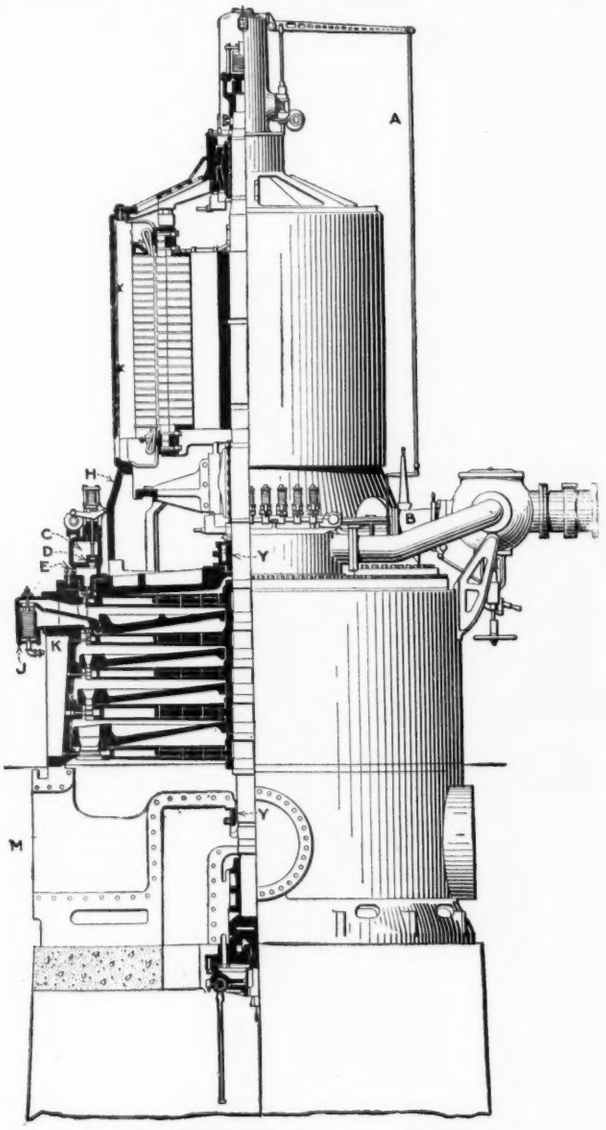


FIG. 4. ASSEMBLY 8000-KW. 1906 TURBINE

In addition, it is now becoming the practice to use feed-water heaters which are in effect continuations of these economizers, although of different material, and which, by reducing the temperature of the stack gases to about 120 deg. F., will add about another 5 per cent. to the thermal efficiency of the station. This gain is net after deducting the power required by a fan, which is used to supplement the stack in the production of the draft.

The operating conditions of such apparatus have been

determined by ample experience in power stations of the larger capacity; and the first cost and operating cost can be readily ascertained.

The attainment of a thermal efficiency of 81 per cent. with blast-furnace gas, as the all-over efficiency of boiler and economizer, without including the feed-water heaters,

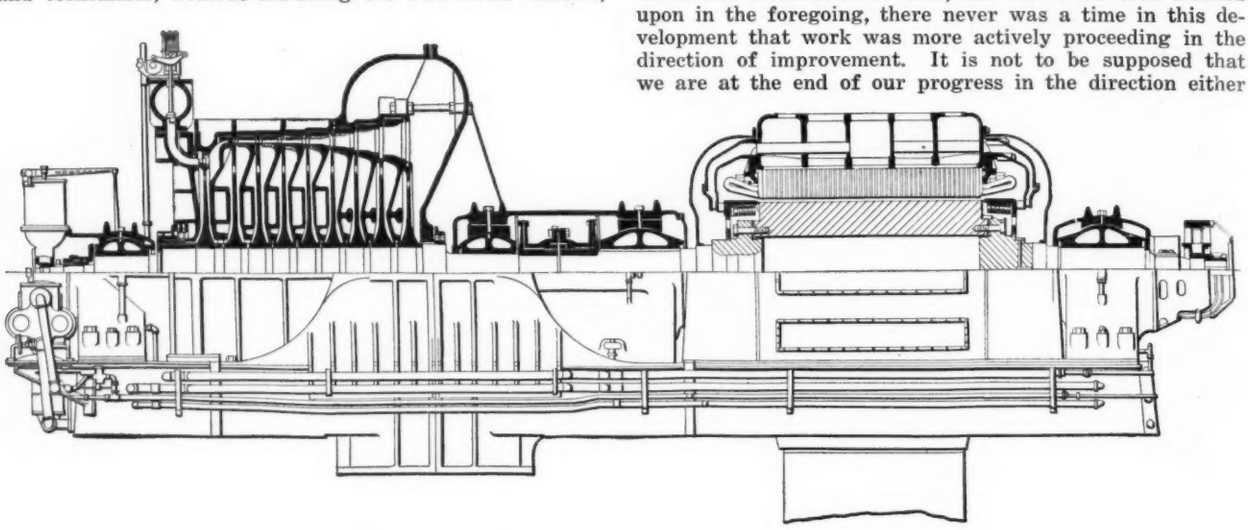


FIG. 5. ASSEMBLY 20,000-KW., 1913, HORIZONTAL TURBO-ALTERNATOR UNIT

is an expectation based on the knowledge and experience of the highest authorities.

Superheater construction for temperatures up to 700 deg. F. is well established by long continuous use, requires no developments and involves no element of doubt.

The first Curtis turbines shipped to the Newport station of the Bay State Electric Co. were of 500-kw. ratings, operated at the start with 29 in. of vacuum or better. These condensers had 4 sq.ft. of cooling surface per kilowatt. By the use of base condensers with vertical turbines, by improved arrangement of tubes, air cooling, drainage vacuum pumps and (with horizontal turbines) improved means of attachment of condensers to turbine shell, this high vacuum has been retained at the condenser with about half the cooling surface, and at the same time the drop between the last turbine bucket and the condenser tubes has been reduced; so that today substantially full vacuum is obtained at the turbine buckets.

It may be freely admitted that such pressures, temperatures and vacua are not to be found in steel mills. In fact,

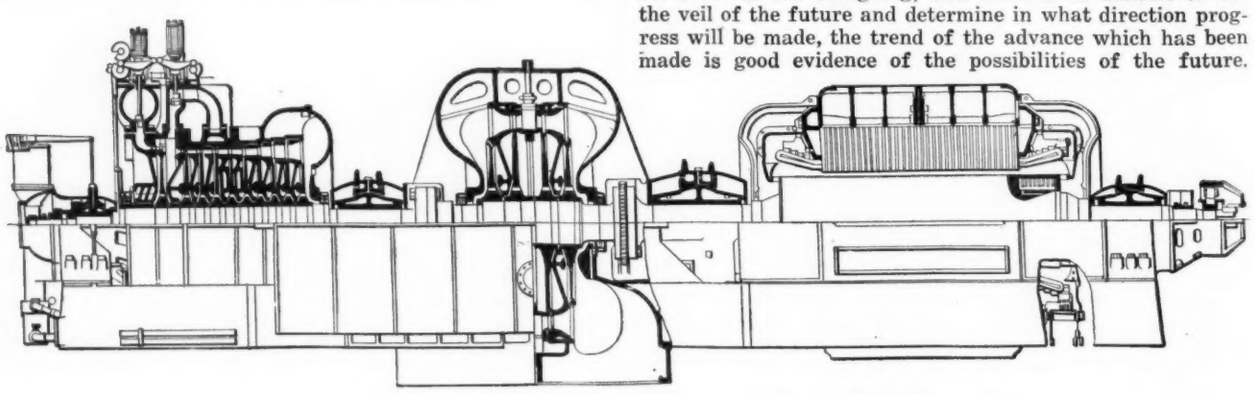


FIG. 6. ASSEMBLY 30,000-KW., 1915, HORIZONTAL TURBO-ALTERNATOR UNIT

in the use of steam, steel mills are years behind present practice.

The use of the high pressures mentioned is, perhaps, not advisable in boilers fired by gas from a blast furnace at this particular moment, although I believe that if this subject is carefully studied and worked out, such pressures and temperatures will ultimately, and in fact in the near future, be used in steel mills. I am convinced from a careful study of the subject that 200 lb. pressure and 200 deg. superheat are today attainable in steel-mill practice without introducing any difficulties of operation.

In spite of these activities and the extent of development which has occurred since 1903, and which has been touched upon in the foregoing, there never was a time in this development that work was more actively proceeding in the direction of improvement. It is not to be supposed that we are at the end of our progress in the direction either of efficiency or of mechanical improvement. The turbine seems to be peculiarly susceptible to the effect of research and of refinement. No other type of prime mover has been found capable of such enormous improvements as have been set forth in the foregoing, and while it is difficult to lift the veil of the future and determine in what direction progress will be made, the trend of the advance which has been made is good evidence of the possibilities of the future. New types of turbine are known which may possess, when properly developed, points of superiority over the machines now in use. Improvements in boiler construction can, and perhaps will, result in making possible the use of higher steam pressures and temperatures. Binary fluid systems may be developed which will increase the heat range utilizable in these plants without going to higher pressure.

TABLE OF HEAT CONSUMPTION

B.t.u. per net kw.-hr. for Stations Supplying 20,000 kw. Average Working Load

	Gas-Engine Plant with Gas-Producer Reserve Column 1	Column 2	Gas-Engine Plant with Steam-Turbine Equalizer Column 3	Steam-Turbine Plant‡ Column 4
Direct heat consumption of main units	17,650	20,060	19,600	18,050
Gas washers	500	500	400	0
Auxiliary pumps	350	350	350	1,300
Igniters, exciters, etc.	500	500	400	*0
Total B.t.u. per net. kw-hr.	18,400	21,410	20,750	19,350
Efficiency of main units, per cent	20.0	17.0	17.4†	18.9
Efficiency of plant, per cent.	18.55	15.9	16.42	17.62

* Direct-connected exciters. † Gas-engine efficiency, 20 per cent.; difference is caused by the equalizing turbine. ‡ Steam conditions—200 lb. gage, 200 deg. F., Super heat, 28.5 in. vacuum.

Shawinigan's Power Plants*

By H. E. Randall

The town of Shawinigan, Quebec, is of comparatively recent origin, and prior to 1898 its entire population lived in one house. Then came the original power development, soon after the Canadian Northern Ry., then the Pittsburgh Reduction Co., then the Canadian Pacific Ry., and soon the wilderness of '98 became a thriving, progressive industrial city, with a population of 12,000 people and manufactured products reaching the $20,000,000 mark in 1916.

Shawinigan lies about twenty miles from Three Rivers, where the St. Maurice River enters the St. Lawrence. The St. Maurice, whose drainage area is upward of 20,000 square miles, has a fall of 150 ft. at Shawinigan. The power has been utilized by four power houses, which now have a capacity of 196,000 hp. The latest power house at this development has five 20,000-hp. units and when constructed in 1910 represented a considerable advance in hydro-electric practice.

Nine miles above Shawinigan the St. Maurice River falls 85 ft. Here is another power house with an installed capacity of 120,000 hp. The plans call for 60,000 hp. of additional capacity, and during construction arrangements were made for the quick installation of this capacity, so that when needed it can probably be installed as fast as the load develops. This power house operates in parallel with the Shawinigan houses, and it supplies the Shawinigan industries as well as feeding the general distribution system of the Shawinigan companies.

Shawinigan's electric power is delivered in large quantities to the City of Montreal. However, the Civic Investment Co.'s 120,000-hp. plant at Cedars, Quebec, thirty miles from Montreal, can supply a large amount of the Montreal load in the future, thus leaving Shawinigan's generating stations for electrochemical industries. It should be noted that the Cedars company has water rights amounting to nearly 100,000 hp. or more, for which machinery is not yet installed. In addition, the Montreal load is supplied by other hydro-electric plants, controlled by the Civic Investment Co. and other companies, aggregating 100,000 horsepower.

Possible Power in the Shawinigan System

As to the future, the Shawinigan company owns the water rights and has plans underway for the development of about 75,000 hp. at Gres Falls, four miles below Shawinigan on the St. Maurice River, where a head of 65 ft. is available. In addition, within one hundred miles of Shawinigan there are other undeveloped water powers aggregating 300,000 hp. Totaling the present developed and possible powers previously mentioned, the immediately visible supply of power available for feeding the Shawinigan system amounts to 1,091,000 hp., of which 680,000 hp. is yet unsold.

The amount of power that can be developed from the St. Maurice River is limited only by the amount of water and the fall available. No consideration of scenic beauty enters into the power situation, and since the entire St. Maurice watershed lies within the province of Quebec, it is reasonable to believe that no interference or abrogation of rights need be looked for. A broad general policy with respect to water-power development has been one of the outstanding features in the progressiveness of the province. This policy is well exemplified in the construction of the largest storage reservoir in the world on the upper reaches of the St. Maurice River, by the provincial government. The water thus stored is leased over a long period of years, for use at times of low water, to the various companies using it for power or other purposes. This storage reservoir, with a dam costing more than $2,000,000, forms a lake 360 square miles in area, and impounds sufficient water to generate 1,000,000,000 kw.-hr. in the power plants of Shawinigan. It is interesting to note that if the level of this lake was raised six feet, the water would begin to flow into the Arctic Ocean rather than into the St. Lawrence River.

Summarizing, it appears that there is now installed 511,000 hp. of generating machinery, feeding the Shawinigan system, and that there is over 40,000 hp. not used and available for immediate delivery, and an additional 60,000 hp. will be available as rapidly as required. There is also 580,000 hp. as yet undeveloped, and this, with the 100,000 hp. as yet unsold, makes 680,000 hp. that is available for electrochemical industries in the St. Maurice Valley. This amount is almost wholly available for this purpose, because the growth of the heavy city load outside the St. Maurice Valley will be amply taken care of by other power plants near the city.

Among the electrochemical industries at Shawinigan is the Pittsburgh Reduction Co., now the Northern Aluminum Co., which uses between 50,000 and 60,000 hp. for reducing refined American bauxite into aluminum; the Canada Carbide Co. utilizes about 40,000 hp. in the manufacture of calcium carbide and acetylene gas; the Canada Aloxite Co. uses over 20,000 hp.; the Belgo-Canadian Co. utilizes 18,000 hp. for the manufacture of paper and pulp; and the Laruentide Co., of Grand Mere, utilizes 28,000 hp. for the same purpose.

The number and size of electrochemical industries at Shawinigan must increase rapidly in the future because with 100,000 hp. now available as fast as plants can be erected to utilize it, and with over 600,000 hp. yet untouched, and with its low power costs, cheap labor and advantageous export rates, it offers a strategic location for serving the European market, which for many years to come must be a large one. At the moment it is one of the few localities in the country where power in quantities can be obtained quickly and cheaply and where the necessary labor for plant operation can be secured without excessive importation. With these present advantages and its future possibilities, it is almost certain that Shawinigan will continue to be the electrochemical center of the Dominion of Canada.

*An abstract from a paper, "Shawinigan and Its Electrochemical Industries," presented at the thirty-second general meeting of the American Electrochemical Society, held in Pittsburgh, Penn., Oct. 3-6, 1917.

Fatal Tube Explosion

An explosion, on Nov. 7, of a 3½-in. water tube in one of the boilers in the Baden pumping station of the St. Louis water works resulted in the death of one fireman and serious injury to another, besides temporarily embarrassing the city's water-supply. The plant consists of eight 300-hp. water-tube boilers, all connected to a single main header. Except for the brief intervals of shutdown for cleaning, these boilers have been in uninterrupted 24-hour daily service since their installation twenty years ago.

The exploded tube was in the sixth horizontal row from the bottom and was the fifth in series counting from the right-hand side. The rupture occurred at about the middle of its length and along the side looking toward the right-hand furnace wall. It opened up for a distance of about 30 in., flattened out vertically, buckled in toward the middle of the row and pulled out of both water-legs. Five tubes contiguous to the burst one were bent more or less by the buckling of the latter, the ends of two of them being nearly or quite drawn out of the sheets.

The eight boilers are fired by hand. The fireman who was scalded to death was engaged at the instant of the explosion in tightening a handhole plate in the front water-leg. It was impossible for anyone to reach the header valve and cut out the damaged boiler in time to keep the other boilers on the line from "dying" outright. The steam pressure dropped from 150 lb. to zero in a few minutes, all of the fires having been drawn in the meantime. It was just such a situation as shows the vital need of automatic non-return valves in header connections, instead of ordinary gate or globe valves.

The interior surface of every part of the damaged boile is remarkably free from incrustation and sediment and th marks of corrosion; so the accident can in no wise be charged to weakening of the tube by overheating or by corrosive action of the feed water. The failure may be attributed to the general deterioration which boiler material exposed directly to the gases of combustion must inevitably suffe through age. The burst tube had been in practically continuous service for twenty years.

The National Welding Council

The following gives the status of the National Welding Council, formed of various engineering interests for the purpose of bringing the autogenous-welding art to such perfection that it may with reasonable assurance safely be applied to pressure vessels.

The movement was initiated by the Compressed Air Society, which, in March, 1917, got the Boiler Code Committee of the American Society of Mechanical Engineers to pass the following resolution:

Resolved: That the Compressed Air Society be requested to submit to the Boiler Code Committee a brief covering the changes or additions it would recommend in the Boiler Code to cover what it regards as equitable rules and regulations covering pressure vessels other than for steam, together with scientific facts and arguments bearing on the proposed changes or additions.

On June 12, 1917, the Compressed Air Society, through the chairman of its Air Receiver Committee, after corresponding broadly throughout the country with manufacturers and organizations interested in pressure vessels other than for steam, secured a meeting of about thirty various representatives, who held an all-day session resulting in the appointment of 24 members, representing eight organizations, with the object of developing ways and means for preparing the brief that was requested by the Boiler Code Committee.

The representatives so appointed were called for a meeting, which turned out to be an all-day session, held Sept. 25 at the Engineering Societies Building, 29 West 39th St., New York City. Those called were: For the Compressed Air Society, G. L. Brunner, chairman; J. W. Gardner, William Prellwitz, George Macloskie and H. B. Conrad; for the American Society of Refrigerating Engineers, F. L. Fairbanks, J. C. McCabe and F. E. Matthews; for the compressed-gas manufacturers, H. C. Smith, G. McM. Godley and F. L. Tunis; for the International Acetylene Association, J. M. Morehead, C. K. Bryce and A. C. Morrison; oxyacetylene-welding apparatus, Henry Cave, H. C. Smith and S. W. Miller; for the electric-welding apparatus, D. C. Alexander, C. A. Carpenter, P. A. E. Armstrong and H. D. McKinney; for the tank manufacturers, Victor Mauck, R. H. Hackney and Thomas Shipley; for the insurance companies, James G. Shaw, T. T. Parker and J. I. Vanash. Nearly all of the foregoing gentlemen were present at the meeting.

The purpose of the meeting was the taking of practical steps for establishing rules and regulations covering the design, manufacture and care of welded pressure vessels other than for steam, with the desire that such rules may eventually be acceptable to the Boiler Code Committee of the American Society of Mechanical Engineers and incorporated in the Boiler Code.

The purpose of the National Welding Council is to establish, as far as possible, exact data and test methods as applying to the art of welded pressure vessels primarily. The Executive Committee consists of the following members: G. L. Brunner, Compressed Air Society; F. L. Fairbanks, American Society of Refrigerating Engineers; H. L. Smith, compressed-gas manufacturers; B. K. Bryce, International Acetylene Association; oxyacetylene-welding apparatus represented by Henry Cave; Charles A. Carpenter, electric-welding apparatus, representative; Mr. Mauck, tank manufacturers; James G. Shaw, insurance companies; and J. C. McCabe, representing the constituted authorities, such as public officers. A. C. Morrison and H. B. Conrad were appointed temporary secretaries of the Executive Commitete.

It was deemed advisable that the Executive Committee hold its meetings the third Wednesday of each month in the rooms of the Engineering Societies Building, New York City. A. C. Morrison, Victor Mauck and H. B. Conrad were appointed members of the Ways and Means Committee for the purpose of securing the necessary financial assistance for carrying on the work of the organization. It was decided that to carry on the work outlined, it would be necessary to engage the services of a consulting engineer, expert in welding, who could conduct experiments and make deductions from data submitted. It was hoped to secure the services of P. A. E. Armstrong. (Readers of *Power* will remember Mr. Armstrong by his article, "Welds—The Weaknesses and Merits of Their Structure," in the issue of June 26, 1917, pp. 856-60.) Unfortunately, Mr. Armstrong is at this time unable to take up the work outlined, but has promised to do what he can for the council.

Suggestions from manufacturers offering their plants and facilities for carrying on practical experiments were appreciated, but the general opinion of the committee was that the burden of costs should not be placed on any particular concern, but all to be benefited by final results should be willing to carry their share of the burden.

The high purpose of the council is most commendable. At the meetings it was conceded that good welds could be made, that some good has come from tests already made, that the large mass of experimental data secured has some value, but all this is not sufficient to produce the conclusions needed for a definite code. A strong plea was made to take up the work on new lines to find the reasons why welds fail and overcome such reasons by the adoption of proper methods for doing the work and also the control of the methods used and the supervision of the human equation. It was argued that definite values should be placed on welded joints as soon as possible and that a satisfactory test be discovered that might be applied to welded pressure vessels.

Civil Engineer Corps, U. S. Naval Reserve Force

An examination will be held at the Bureau of Yards and Docks, Navy Department, Washington, D. C., to establish a list of eligibles for enrollment in the Civil Engineer Corps of the United States Naval Reserve Force. This examination will close at noon of Dec. 31, 1917.

To compete in this examination it is only necessary for the candidate to address a letter to the Reserve Examining Board, giving full information as to his education and experience, with testimonials and references. A descriptive circular giving detailed information of the requirements will be sent to interested parties upon request to the Chief of the Bureau of Yards and Docks, Navy Department, Washington, D. C. Candidates recommended for enrollment will be authorized to appear before the nearest medical officer of the United States Navy for physical examination. Those found to be physically unfit will not be enrolled.

Candidate must be an American citizen and must be an engineer in active practice of civil, electrical or mechanical engineering or some business directly connected with these professions. The age and experience requirements are: For ensign, not less than 24 years of age with not less than two years of active professional practice; for lieutenant (junior grade), not less than 27 years of age with not less than five years of active professional practice; for lieutenant, not less than 30 years of age with not less than seven years of active professional practice, during at least three years of which candidate must have had responsible charge of work as principal or assistant.

Those now in the United States Naval Reserve Force, civilians and anyone who is now in the army, either volunteer or drafted, including those directed to appear before an exemption board, may make application, but those in the army, either volunteer or drafted, must obtain their discharge before they can be enrolled.

Enrollments are for a period of four years or during the existence of a war or national emergency. Except during a war or national emergency officers are only given active duty at their own request, and then for short periods.

Pay and allowances of officers amount to, approximately, as follows: Ensign, $2100 per annum; lieutenant (junior grade), $2500; lieutenant, $3100. There is an additional allowance of $150 per annum for uniforms.

Defects in Cast Iron—Small defects in iron castings may be filled with a composition made by fusing together nine parts of lead with two of antimony and one of bismuth. This alloy expands on cooling and will keep its place.

Restricting the Use of Electric Signs

The United States Fuel Administrator has issued the following order regulating the use of coal for the purposes of generating electricity for use in operating illuminated advertisements, notices, signs, etc.:

It appearing to the United States Fuel Administrator that it is essential to the national security and defense, the successful prosecution of the war, and the support and maintenance of the Army and Navy, to lessen or prevent the waste of coal which at the present time is and during the continuation of the war will be, in the judgment of the United States Fuel Administrator, needed for the purposes aforesaid, and to secure an adequate supply and equitable distribution, and to prevent, locally and generally, scarcity of coal, and to facilitate the movement of coal for the purposes aforesaid, that the use of coal in the manner and for the purposes hereinafter set forth, and that the employment for such use of the present facilities already inadequate for the prompt and sufficient shipment, transportation and delivery of coal needed for the purposes aforesaid, should be limited and restricted, in order that the essential purposes first hereinbefore referred to may be carried out, and that so far as possible the production, sale, shipment, distribution and apportionment of coal among dealers and consumers, domestic and foreign, may be maintained to the extent sufficient to meet the governmental, commercial and domestic requirements for coal,

The United States Fuel Administrator, acting under authority of an Executive Order of the President of the United States, dated Aug. 23, 1917, appointing said Administrator, and in furtherance of the purpose of said order and of the Act of Congress therein referred to and approved Aug. 10, 1917,

Hereby adjudges that in his opinion the use of coal for any of the purposes hereinafter described except to the extent hereinafter indicated is wasteful, and that any person using any coal for such purposes except as aforesaid is engaging in a wasteful practice or device in handling or dealing with coal, and that the use of coal for such purposes except as aforesaid is prejudicial and injurious to the national security and defense, and a cause of scarcity, locally and generally; and

Hereby orders and directs that until further or other order of the United States Fuel Administrator and subject to modification hereafter from time to time and at any time,

1. Upon and after the 15th day of November, 1917, no corporation, association, partnership or person engaged in whole or in part in the business of furnishing electricity for illuminating or power purposes, and no corporation, association, partnership or person maintaining a plant for the purpose of supplying for their own use electricity for illuminating or power purposes, shall use any coal for the purpose of generating, producing or supplying electricity, or supply or use electricity generated or produced, in whole or in part by the consumption of coal, for the purpose of providing, maintaining, lighting or operating, before the hour of 7:45 p.m. or after the hour of 11 p.m., electrically illuminated or display advertisements, notices, announcements, signs, designation of the location of an office or place of business or of the nature of any business, electric searchlights or (external) illumination or ornamentation of any building, except in the interior of buildings, and except as in special cases hereinafter further or otherwise provided or limited, namely:

(a) This order shall not apply to the United States Government, the government of any commonwealth or state of the United States, or to any city, county, town or other governmental subdivision in any such commonwealth or state;

(b) This order shall not apply to the maintenance of street lights by any city or town or within any city or town under a contract with the officials thereof for such maintenance, or to the maintenance of any lights for any purpose by, or in compliance with orders of, any public authorities;

(c) Electric signs affixed to the street fronts of buildings, over the street entrances thereof or over the street entrances to stores, shops or other places of business therein, or extending therefrom over the sidewalks, for the purpose of announcing the name or business of a retail shop or store, or the name and location of a theater or other place of amusement or of a hall or other place of public assembly, together with the name of the play or other entertainment given therein, or of the purpose of any public assembly to be held therein, as the case may be, may be lighted or illuminated or operated by electricity, generated or produced by the use of coal, during the period from one-half hour after sunset until such time, not later than 11 o'clock in the evening, at which time in the case of a place of business the same is closed for the conduct of business therein in the same manner and to the extent that such business is conducted therein during the daytime business hours, and in the case of places of amusement and public assembly hereinbefore referred to until one-half hour after the time fixed for the beginning of an entertainment or of the meeting or other public assembly, as the case may be: Provided, that the size of any such sign and the amount of electricity needed to operate and illuminate the same shall be reduced at any time upon direction of the state fuel administrator of the state within which such sign is located;

(d) This order shall not apply to porch lights upon houses or hotels, or at the entrances to buildings occupied or open for ingress or egress during the nighttime, or to lights upon private driveways, walks or in the grounds of any hotel, manufacturing establishment or residence, or upon the platforms of railroad stations, approaches thereto, or in railroad yards or grounds, or to lights to mark the location of fire-escapes or exits; or to lights for any similar purposes when authorized by any state fuel administrator of the state within which such lights are located: Provided, however, that the number and power of any such lights by this paragraph (d) permitted shall be reduced at any time upon direction of the state fuel administrator of the state within which such buildings or grounds are located;

(e) Nothing herein shall be construed to extend the length of time, fixed by agreement or otherwise, between any person and a state fuel administrator, for which any such sign or illumination may be displayed or operated.

2. The state fuel administrators within the several states are hereby directed and authorized to see that the provisions of this order are observed and carried out within their several states, to report violations thereof to the United States Fuel Administrator and to recommend to the United States Fuel Administrator action to be taken by him with respect to the sale, shipment, distribution and apportionment of coal to the corporations, associations, partnerships or persons so found to be acting in violation of this order.

H. A. GARFIELD,
United States Fuel Administrator.

Meeting of Connecticut Section A. S. M. E.

The Connecticut Section is new in A. S. M. E. organization. Heretofore there have been only city sections. The Connecticut Section had its inception in Meriden, Conn., and is a combination of all sections in Connecticut. Because of the area of the state and the number of engineers per unit of area, the section has a bright future.

The first meeting was held Wednesday afternoon and evening, Nov. 14, at Yale University. The afternoon session was held in Lampson Lyceum and was presided over by Henry H. Sargent. The purpose of the afternoon and evening meetings was to discuss means of fuel conservation. The chief paper was presented by Prof. L. P. Breckenridge, of the department of mechanical engineering, Yale University. "Power" will probably publish abstracts of this paper and that of O. P. Hood, chief engineer, also the discussion following these papers.

A feature of the evening session, held in Mason Laboratory, following a dinner at the Yale Dining Club, was an address or, rather, an appeal by Ira N. Hollis, president of the American Society of Mechanical Engineers, to engineers to exert their influence in making the characteristic of the Twentieth Century that of service to mankind.

Among those contributing interesting discussions at the afternoon session were R. J. S. Pigott, of Bridgeport; Perry Barker, of Boston; and J. Russell, fuel administrator for Connecticut. Mr. Pigott urged the need of the wider use of the bleeder-type turbine where conditions are suitable, as they are in many factories, and of the stoker, so well adapted for burning the lower grades of coal. He pointed

out that with the bleeder-type turbine, where conditions were suitable, the heat return to the plant from the heat generated or supplied was about 24 per cent., as against 12 per cent. for the straight turbine. It is Mr. Pigott's opinion that we will find no economically desirable substitute for coal and that economies due to new and improved equipment for particular plants can be had only by installing such apparatus in extensions to those plants. The speaker said that it was his experience that 13 to 14 per cent. CO_2 was the most economical to strive to maintain and that 15 or 16 per cent. was not as indicative of the excellent results commonly attributed to them.

Perry Barker emphasized the need of cutting down the losses to the stack.

The section will, on motion of Professor Breckenridge, appoint a committee to assist the state fuel administrator and to promote, through the local sections in the state, economy in fuel use.

The evening session opened with an address by Mr. Hood, who told of the functions of the Bureau of Mines, its past work in fuel-economy investigations and, unfortunately—for the fact; not the telling of it—of the handicap the bureau is burdened with because of the loss of some of its men to the war. Mr. Hood emphasized the urgent need of stamping out fuel fallacies, of which there are many, he declared. Among these are the "coal-saving compounds," so many of which have been exposed in these columns. The fuel-economy situation, he said, needs a Billy Sunday type of exponent, who can get at and convince the people that to save fuel is vitally necessary. Mr. Hood also claimed that some of the increased coal production is not coal production at all, but greatly increased production of refuse in the coal. He said the coal recently delivered to one Government building contained 26 per cent. ash and 26 per cent. moisture. The bureau is keeping tabs on the character of the output of many mines.

Considerable publicity is necessary in this fuel conservation by economy in consumption; but, said Mr. Hood, every measure should be taken to see that no fallacies went forth to the public. He intimated that the bureau was taking steps to try, with the aid of committees of engineers, to censor much of the publicity matter, particularly, and perhaps he meant exclusively, newspaper "stories."

Those present at the afternoon session were entertained by moving pictures showing the manufacture of steel pipe from the ore to the finished pipe by the National Tube Co. J. Arnold Norcross, chairman of the evening session, expressed appreciation for the large attendance and the interest displayed.

N. E. L. A. Educational Courses

Fred R. Jenkins, chairman of the Committee on Education of the commercial section of the National Electric Light Association, has recently issued a notice calling attention to educational correspondence courses open to members of the association and employees of member companies. Three courses are given—Electric Utility Accounting, Practical Electricity, and Commercial Engineering. The course in Electric Utility Accounting is divided into two sections—an elementary course in bookkeeping and accounting consisting of 7 lessons, and an advanced course in public-utility accounting comprising 36 lessons. The latter is a highly specialized one.

The announcement calls attention to the fact that these courses have been established in response to a very evident demand for standard instruction in accounting for the electrical industry. The intention is to supply the needs of all classes of employees in whose work accounting is a factor, and to enable individuals working more or less independently in small companies with many varied problems to train themselves. The intention has been to meet the requirements of groups of men engaged in specialized work in the larger companies.

The course of ten lessons in Practical Electricity is prepared for practical men who are engaged in the manufacture, sale or operation of electrical apparatus and covers a selection of subjects that will give the best knowledge of the necessary fundamental principles. The lessons are written in simple language without the use of advanced mathematics and can be easily understood by the nontechnical man.

The committee urgently requests full coöperation of members and member companies in seeing that all employees eligible to this course are fully acquainted with the opportunity, and further suggests that each company through its educational director or someone appointed for that purpose take an active interest in forming a company class.

Commercial Engineering, a course of 17 lessons, deals with the commercial side of the central-station business and is intended to assist the student to keep pace with the rapid development in the application of electricity.

Coal Regulation in Canada

Detailed regulations governing the importation, distribution, sale and delivery of coal in Canada have been prepared by the Fuel Controller and are fully ratified, according to a recent issue of *Commerce Reports*. The right to import coal into Canada or to engage in the business of selling coal as a broker, wholesaler, or retailer is made subject to license by the Fuel Controller, application for which must be made in the prescribed form so that hereafter no one may enter the business without having first secured the necessary permit.

The regulations also contain provisions regarding the fixing of prices at which coal may be sold at wholesale and retail. Coal operators may be required to enter into agreements fixing the maximum prices to be charged for their output. The commissions or profits that may be derived in coal transactions by brokers, wholesalers and retailers are fixed at 30, 35 and 50 cents per net ton, respectively. In determining the maximum prices to be charged by wholesalers or retailers the basis of the computation is to be the actual delivered cost on the first or sixteenth of the month in course, with the addition of the expenses incurred and the permitted commission or profit.

With certain exceptions, and subject to contracts existing at the date of the regulations, no broker or dealer may sell or deliver to a consumer a quantity of coal which, added to the quantity already in the possession of the purchaser, would constitute more than an estimated supply sufficient for the consumer's needs for two months, and certificate to that effect may be required at the time of purchase. No such limit will be imposed, however, during the period from Apr. 1 to Sept. 1 of each year; and an exception is made for railways, munitions plants and certain institutions, as well as for coal for other purposes, when the quantity does not exceed three tons. In case of emergency the Fuel Controller may requisition stocks of coal in excess of the supply permitted.

New York Compensation Act Applied

Under the clause of the New York Workmen's Compensation Act declaring the "repair of stationary engines" to be one of the hazardous employments in which the employer shall be liable to pay compensation for injuries sustained by employees in the course of their work, it was lately decided by the Appellate Division of the New York Supreme Court that one employed to assist in putting a flywheel on a gas engine used by the employer in pumping an oil well could not be regarded as coming within the statute, and hence there could be no compulsory award on his being killed through explosion of the flywheel.

The court holds that the clause is limited to cases where the employer is engaged in repairing engines for pecuniary gain, and that it does not apply to injuries sustained by workmen in repairing an engine used in an occupation not declared to be hazardous under the Compensation Act. (Tillburg vs. McCarthy & Townsend, 166 New York Supplement, 878.)

It is noted in the decision, however, that since the accident in question occurred, the law has been so amended as to now embrace the operation of oil and gas wells as a hazardous occupation.

Personals

Samuel Riebel, for the last 14 years engineer of the power plant of the Commonwealth Electric Co., Summit, N. J., has resigned his position.

M. H. Flexner, formerly in the power division of the Commonwealth Edison Co., of Chicago, is now connected with the Booth-Hall Co., of same city.

D. M. Ferguson, formerly of the National Transit Co., has been appointed director of publicity for the American Steel Exports Co., Woolworth Building, New York City.

R. N. Allen, electrical and maintenance engineer of the Port Commission, City of Seattle, Wash., for the last three years, recently resigned his position. No successor has been appointed.

John Hunter, chief engineer of the Union Electric Co., St. Louis, has received a temporary leave of absence to depart for the East as a district superintendent for the United States Emergency Fleet.

John R. Du Priest, formerly head of the mechanical-engineering department of the University of Idaho, Moscow, is now professor of steam- and gas-engine design at Rensselaer Polytechnic Institute, Troy, N. Y.

Claude C. Brown, formerly in the steam department of the Pacific Gas and Electric Co., has become power engineer for the Hawaiian Sugar Refinery Co., at Crockett, Calif., in charge of steam and electric operation and construction.

R. J. Morgan, who resigned his position with the Midvale Steel and Ordnance Co., has been appointed supervisor of sales of the American Steel Export Co., New York. Prior to his connection with the Midvale Steel and Ordnance Co., he spent 13 years with the Carnegie Steel Co.

W. O. Renkin, who spent some years as resident engineer in charge of the organization and construction of the works and town of Sakchi, Bengal, India, for the Tata Iron and Steel Co., and for some years past has been chief engineer with the A. M Byers Co., of Pittsburgh, Penn., has resigned to become manager of the engineering department of the Quigley Furnace Specialties Co., 26 Cortlandt St., New York, specialists in powdered-coal installations.

H. F. Gauss has been appointed chief inspector of boilers, elevators and smoke abatement for the City of St. Louis. At the recommendation of the Engineers' Club and the local section of the American Society of Mechanical Engineers, he was transferred from his position as principal assistant mechanical engineer in the water department to the one he now holds. It is the intention of the department to establish an educational smoke-abatement campaign and secure the coöperation of fuel users in an endeavor to eliminate dense smoke and comply with the city's smoke ordinance. Court proceedings will be the last resort. The present condition of the fuel market in and around St. Louis will make difficult many problems relating to the smoke nuisance, but it is the belief of Mr. Gauss that with proper furnace construction and manipulation of the fires a great deal can be accomplished even with a poor grade of coal.

Obituary

James F. Meagher, former president of the People's Gas, Light and Coke Co., of Chicago, and a corporation lawyer of considerable note, died on Oct. 30 at Greenwich, Conn.

George Harrison Klumph, late Western manager of the Green Fuel Economizer Co., was drowned while fishing on Lake Eva, in southern Manitoba, on the morning of Nov. 4. He was 55 years old, is survived by his widow and three children and is mourned by a large circle of friends in the engineering fraternity.

William D. Kearfott, president of the Kearfott Engineering Co., died at his home in Montelair, N. J., on Nov. 12, of apoplexy. He was 53 years old, an authority on engineering subjects and the author of many technical books. His first business connection was with the Morton Tool Co., of Wilmington. He was subsequently with the International Navigation Co., the Worthington Steam Pump Co. and the Warren Steam Pump Co. He was a member of the Naval and Marine Engineering Society, the Smithsonian Institution and some local social clubs. He is survived by his widow, one son and a daughter.

Engineering Affairs

The Virginia Ice Manufacturers' Association will meet at Norfolk, Va., Jan. 9-11, 1918.

The American Society of Refrigerating Engineers will hold its annual meeting in the Engineering Societies Building, 29 W. 39th St., New York City, Dec. 3-5. William H. Ross, secretary, 154 Nassau St., New York City.

The National Institute of Inventors will hold its next meeting Friday evening, Dec. 7, at the Broadway Central Hotel, New York City. Mr. Apostolff, an electrochemical engineer and inventor of a new type of storage battery, will give an address on this battery.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hold a meeting on Dec. 1. O. H. Eschholz, of the Westinghouse Electric and Manufacturing Co., will read a paper on "Some Recent Investigations in Arc Welding."

The Council of the American Society of Mechanical Engineers has appointed the following persons as a committee on the Standardization of Feed-Water Heaters: V. J. Azbe, Bert L. Baldwin, T. J. Cookson, G. F. Gebhardt, J. J. Hoppes and F. E. Idell.

The Pittsburgh Section of the Association of Iron and Steel Electrical Engineers will hold a joint meeting with the Cleveland District Section at the Hotel Courtlandt, Canton, Ohio, on Nov. 24. The following papers will be read and discussed: "Central Station Power," by W. A. Hornlein; "Electric Furnaces," by J. D. Donovan.

The St. Paul Chapter of the American Association of Engineers, newly organized, held a banquet at the St. Paul Association of Commerce on Nov. 7. Major J. A. Irwin welcomed the association on behalf of the city. Greater engineering coöperation was established by passing a resolution providing for all engineering clubs and societies to further the activities of the association in the Twin City district.

The Chicago Chapter of the American Association of Engineers recently held a banquet at the City Club, at which were many engineers of note. Capt. Robert W. Hunt, who has spent 28 months in the trenches, gave an interesting talk in which he emphasized that this is an engineers' war. Dr. F. H. Newell, head of School of Civil Engineering, University of Illinois, discussed the activities of the association.

The Engineering Council met on Oct. 11 in the rooms of the American Society of Mechanical Engineers, Engineering Societies Building, New York. The Rules Committee submitted a draft of rules for the admission of other societies to the Council, and progress was made in their consideration. The Committee on Public Affairs reported on a number of requests that the Council support pending or proposed legislation. Remedial laws intended to promote hydro-electric development were favored and the Council voted to offer its coöperation to the United States Chamber of Commerce, which is interesting itself in this matter. A movement to coördinate, unify and strengthen the work of various engineering committees coöperating with the Federal authorities at Washington was favorably considered. H. W. Buck and Charles Whiting Baker were appointed Council conferees.

The Uniform Boiler Code adopted by the New York State Industrial Commission, requires all boiler inspectors employed by insurance companies, authorized by the State Insurance Department to inspect boilers, to hold a certificate of competency issued by the Industrial Commission. This certificate is issued only after the inspector has been examined by an examining board provided for in the code. This board is as follows: Commissioner James M. Lynch, chairman; Geo. A. O'Rourke, chief engineer of the State Industrial Commission; George B. Hunt, of the Ames Iron Works, Oswego, representing the boiler manufacturers; James G. Shaw and Joseph H. McNeill, representing insurance companies; George C. Purington, Buffalo, representing stationary firemen; George Riley, Buffalo, representing steam and operating engineers, and George Muir, representing boilermakers. The examining board met in the offices of the Industrial Commission, Iroquois Building, Buffalo, on Oct. 24, to hold the first examination.

Miscellaneous News

Second Liberty Loan subscriptions made by the employees of the principal plants of the Link-Belt Co. and by the company itself, amounted to $269,000.

Refrigeration for the Army—The Vilter Manufacturing Co., Milwaukee, Wis., announces that 3350 tons of its refrigerating machines are in France for the United States Government for installation in a 500-ton ice plant, which will manufacture ice for the storage of 5000 tons of roast beef, also for the storage of other foods for the United States Army. The following eight cantonments have been equipped with the Vilter ice and refrigerating machines: Ayer, Mass.; Wrightstown, N. J.; Admiral, Md.; Yaphank, L. I.; Chillicothe, Ohio; Battle Creek, Mich.; Rockford, Ill.; Fort Riley, Kansas. A plant is also being built for the Rock Island (Ill.) Arsenal.

St. Paul Railroad Electrification—The Chicago, Milwaukee & St. Paul R.R. has decided to rush the electrification of its Cascade Mountain section running from Othello, Wash., to Seattle and Tacoma. The present urgent necessity for conserving the nation's fuel resources is the reason for the speeding up of this work. Hundreds of thousands of barrels of fuel oil will be saved annually, since under electrification the railroad will use power generated by the waterfalls of the Cascade Mountains; and to save this fuel as soon as possible, contracts for the locomotives and the power-transforming apparatus have been divided between the Westinghouse Electric and Manufacturing Co. and the General Electric Co. This section of the railroad is 211 miles long and is in addition to the 440 miles already operated electrically over the Bitter Root, Rocky and Belt Mountains, between Avery, Idaho, and Harlowton, Montana.

Business Items

The Vulcan Furnace Co., of Erie, Penn., has placed its interests in the hands of the Acme Furnace Equipment Co., 39 Cortlandt St., New York, of which John C. Quinn is president.

Nagle Corliss Engine Works of Erie, Penn., has opened an office at 39-41 Cortlandt St., New York City, with Frank W. Richardson in charge. This gives direct representation and immediate personal attention to all inquiries.

The Diamond Power Specialty Co., of Detroit, Mich., has received a large order from the United States Government for soot blowers to equip the boilers installed for heating and refrigerating purposes in the first American cantonment in France.

The Consumers Power Co. is making an addition to its power plant at Grand Rapids, Mich., installing one 10,000-kw. turbine and two 2365-hp. Stirling boilers, similar to those in use at the Delray Station of the Detroit Edison Co. The installation will probably be completed by Dec. 1.

The Atlanta Repair Shop of the General Electric Co. is fully equipped to give its customers repair service on all classes of direct- and alternating-current apparatus. Correspondence in regard to repair work should be addressed to the Engineering Department, General Electric Co., Third National Bank Building, Atlanta, Ga.

The De La Vergne Machine Works, of New York City, well known in connection with the manufacture of refrigerating machinery and internal-combustion engines, has been acquired by the Cramp Ship and Engine Building Co., of Philadelphia, and will be used by it for the construction of marine engines, according to Charles T. Taylor, secretary of the Cramp Company.

The O'Neil Iron Works, Inc., of Buffalo, has purchased the Lake Erie Boiler Works, of the same city, which was for many years owned by Richard Hammond & Sons. The new company is to be capitalized at half a million dollars. The O'Neils formerly owned the Fulton Iron Works, of St. Louis, capitalized at $5,000,000, and known as the largest cane-sugar mill machinery plant in the world. The plant was recently sold to a corporation of St. Louis business men.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Nov. 15, 1917	One Year Ago	Nov. 15, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Nov. 15, 1917	One Year Ago	Nov. 15, 1917	One Year Ago
Clearfields....	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets..	.....	3.10—3.85	.....	4.60—5.40

Note—Bituminous not on market.

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.50—8.75.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Nov. 15, 1917	One Year Ago	Nov. 15, 1917	One Year Ago
Buckwheat ..	$3.95—4.65	$2.75	$5.10—5.30	$4.25—4.50
Rice	3.40—3.60	2.20	3.80—4.10	3.00—3.25
Barley	2.90—3.15	1.95	3.00—3.30	2.10—2.25

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Nov. 15, 1917	One Year Ago	Nov. 15, 1917	One Year Ago
Buckwheat ...	$2.90	$2.00	$3.80	$2.90
Rice	2.40	1.25	3.40	2.15
Boiler	2.20	1.10	3.30	2.00
Barley	1.90	1.00	2.15	1.90

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Nov. 15, 1917	One Year Ago
Slack	$3.00—3.25	$4.00—4.50
Mine-run	3.00—3.25	5.00
¾-in.	3.50—3.75	3.35—3.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Counties Williamson and Franklin	Harrisburg Saline and	Smokeless West Virginia	field Spring-	Counties Clinton and Sullivan
Steam lump ..	$2.65	$2.65	$2.70	$2.65	$2.65
Lump	2.65	2.65	2.70	2.65	2.65
Egg	2.65	2.65	2.70	2.65	2.65
Nut	2.65	2.65	2.70	2.65	2.65
No. 1 nut....	2.65	2.65	2.70	2.65	2.65
No. 2 nut....	2.65	2.65	2.70	2.65	2.65
No. 3 nut....	2.65	2.65	2.70	2.65	2.65
No. 1 washed.	2.65	2.65	2.70	2.65	2.65
No. 2 washed.	2.65	2.65	2.70	2.65	2.65
Mine-run	2.40	2.40	2.40	2.40	2.40
Screenings	2.15	2.15	2.20	2.15	2.15

Hocking lump, $2.60; splint lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Nov. 15, 1917	One Year Ago	Nov. 15, 1917	One Year Ago	Nov. 15, 1917	One Year Ago
6-in. lump ..	$2.65	$3.25	$2.65*	$3.50	$2.65	$2.50
2-in. lump ..	2.65	....	2.65*	....	2.65	2.00
Steam egg...	2.65	....	2.65*	2.75	....	1.75
Mine-run	2.40	2.50	2.40*	2.25	2.40	2.00
No. 1 nut...	2.65	3.25	2.65*	2.75	2.65	2.25
2-in. screen..	2.15	2.25	2.15*	2.25	2.15	1.25
No. 5 washed	2.15	2.50	2.15*	....	2.15	1.50

*Strike.

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ark., Buffalo—The Standard Zinc Co. plans to build a hydro-electric plant on the Buffalo River.

B. C., Greenwood—The West Kootenay Power and Light Co., Rossland, plans to build a new 100-mile power transmission line.

Calif., Morgan Hill—City is taking under consideration plans for the installation of an electric-lighting plant.

Calif., Oroville—The Bloomer Quartz Mine Co. plans to install a large hydro-electric plant in connection with its mine.

D. C., Washington—(Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., soon receives bids for furnishing at various navy yards under Schedule No. 1563, brass air cocks, pet polished T-handle air cocks; brass steam and water air cocks; steam and water brass joints; under Schedule No. 1652, bronze automatic and nonautomatic water gages; under Schedule No. 1564, steam and water, flanged, low pressure and high-pressure, brass valves; under Schedule No. 1565, composition bends, pipe fittings, etc.; composition unions, pipe fittings, etc.

Ill., Malta—The City Council has plans under consideration for the installation of an electric-lighting plant here.

Kan., Barnes—City voted favorably on a $10,000 bond issue for the installation of an electric-lighting plant.

Md., Highlandtown—The Crown Cork and Seal Co., 1511 Guilford Ave., Baltimore, plans to build an addition to its power plant here.

Mass., Boston—(Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., soon receives bids for furnishing at Navy Yard, Boston, under Schedule No. 1562, 120 forced lubrication brass air gages and 24 forced draft brass air gages; under Schedule No. 1563, brass stop cocks.

Minn., Chisholm—City is having plans prepared by A. Puck, Arch., Torrey Bldg., for a power house.

Minn., Manchester—City voted on a $8000 bond issue for the installation of an electric-lighting system.

Neb., Pierce—City plans to install a water-power and steam electric plant. Estimated cost, $25,000.

N. J., Newark—The United Color and Pigment Co. plans to build a 1-story, 46 x 90-ft. power plant on Evergreen Ave.

N. J., Trenton—The Luzerne Rubber Co., Muirhead Ave., plans to build a new boiler house and install 2 new boilers. Estimated cost, $20,000. B. Bedford, 22 Fisher Pl., Pres.

N. M., Mexico—The State Line Utilities Co., recently incorporated with $30,000 capital stock, has been granted a franchise to build an electric transmission line from its power plant here to Clovis and thence south to Portale. Noted Sept. 18.

N. Y., Brooklyn—W. Beckers Aniline and Chemical Co., East 83rd St., will build a 1-story brick power house and an addition to its coal bin.

N. Y., Cobleskill—City has under consideration the installation of an electric-lighting plant here.

N. D., Bantry—City plans to install a larger electric-lighting system than the one now in use.

N. D., Garrison—City has plans under consideration for the instalaltion of an electric-lighting plant.

Ohio, Elyria—The Willys Overland Co. has had plans prepared for the construction of a boiler house at its local plant.

Ohio, Zoar—The Zoar Battery Co. has been granted a franchise by the County Commissioners to build an electric transmission line from here to Mineral City.

Okla., Lawton—The Lawton Gas and Electric Co., recently incorporated with a capital stock of $300,000, plans to build and operate an electric-lighting and power plant.

Okla., Loco—City has plans under consideration for the installation of an electric-lighting plant here. C. A. Fletcher & Co., of Loco, is interested.

Penn., Philadelphia—Winfield S. Barnes & Co., 1614 Cherry St., plans to build a power plant in connection with its plant in the Frankford section. Estimated cost, $75,000.

Penn., Williamsport—The United States Rubber Co. has plans under consideration for the construction of a large power house at its local plant.

Wash., Puget Sound (Bremerton, P. O.)—(Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., soon receives bids for furnishing at Navy Yard, Puget Sound, under Schedule No. 1564, 12 composition pressure reducing valves, 300 composition radiator globe valves, and 120 composition adjustable relief valves.

W. Va., Peytona—The Laurel Branch Coal Co., of St. Albans, recently incorporated with a capital stock of $50,000, plans to install a power plant and mining machinery. M. Moore, St. Albans, Mgr.

Wis., Eau Claire—The Gillette Rubber Co. plans to build a 65 x 81-ft. boiler house and transformer station with a 175-ft. concrete stack 15 ft. in diameter. The equipment will include two 315-hp. Stirling boilers, hydraulic pumps, open switchboard and overhead coal bunkers with automatic stocker. R. B. Gillette, Gen. Mgr.